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Armature Reactions. THE electromagnetic reactions occurring in armatures of various types have been often discussed from all sorts of standpoints, but in this treatment the open coil armature, so very extensively used for arc machines, has been rather neglected. A paper elsewhere in our columns gives a special investigation of the reactions met in such cases with their application to the individual study of the Thomson-Houston arc machine. Practical men often look askance at researches of this description, but "the proof of the pudding is in the eating," and the close correspondence of the derived results with those found in the actual machine is enough to suggest that theory in this case is to be treated with some respect. The Thomson-Houston machine is particularly uncomfortable to investigate, owing to the singular winding and to the very extraordinary form of the magnetic circuit, so that methods which would lead to correct deductions concerning its performance are not likely to fail when applied to other open coil dynamos. The paper is a valuable addition to the literature of electromagnetic induction as found in everyday use, especially as the subject of armature reactions is a somewhat abstruse one and all light thrown upon it is particularly welcome.

The Oerlikon Alternator. IN another column is presented a very interesting letter from Mr. Carl Hering, our European correspondent, devoted especially to the description of the Oerlikon three-phase alternator, such as is to be used for the long distance transmission of power from Lauffen to Frankfort. The armature is fixed and the field magnet revolves; the armature circuits are arranged, of course, to give three alternating currents, differing in phase by 120 degrees, and each circuit is wound for 50 volts and 1,400 ampères. The field magnet is especially worthy of attention, owing to its very curious form, which is fully shown in the illustrations. Altogether the machine seems to be very simple and compact, showing the same evidences of good designing that characterize most of the machines turned out from the Oerlikon Works. We await anxiously the report of the performance of these dynamos that will be forthcoming as soon as the Lauffen-Frankfort plant is in full operation, which will probably be some time early in September. We have already expressed ourselves as confident of the success of the experiment. Of course complete and immediate success is almost too much to be hoped for in any enterprise of so novel a character, but the difficulties which may be encountered should soon vanish through the efforts of the skillful engineers who have the work in charge.

Measurement of Alternating Currents. ON another page will be found a paper on methods of measuring power furnished by alternating currents by Prof. Ayrton and Dr. Sumpner. The alternating current was for a time something of a bugaboo to the experimenter; it possessed a number of queer properties which he was quite unprepared for, and was liable to lead him direfully astray if he attempted to measure it by the ordinary methods. Spurious resistances due to induction, counterfeit currents due to change of phase and similar unexpected happenings made the task of the investigator anything but a pleasant one. Within the past few years, however, a number of very simple and beautiful methods of measuring the power delivered to any alternating current apparatus have been introduced, perhaps the most elegant of them being the use of an electrometer with two needles, constituting a very perfect electrostatic wattmeter. This and a number of similar methods and their relations to analogous direct current measuring devices are very clearly and fully discussed in this paper of Prof. Ayrton and Dr. Sumpner, which forms a capital résumé of the best modern practice in the measurement of alternating currents. As time goes on all this will become more and more widely known and appreciated, as well as more necessary, for the alternating current has rapidly worked its way into use and its possibilities are more and more appreciated, as well by the practical engineer as by the theorist.

A Peculiar Performance. IT has transpired that the engineers of the Rapid Transit Commission are now busily at work on plans of their own for the construction of the underground road that has been recommended. In due time they will doubtless report, and it will then be somewhat interesting to see in how far their originality has been enabled to combine the very numerous free suggestions and specifications that they have obtained. At that time, probably, the engineers who have spent a large amount of time and money in working up elaborate detailed arrangements and presenting and explaining them to the aforesaid engineers of the Commission may be enlightened as to the part that their labors are to play in the completion of a rapid transit system for New York. What credit, if any, they will obtain for their suggestions remains to be seen. Their position is a somewhat anomalous one; if their instruction was really needed by the employés of the Commission, it would strike the casual observer that it would have been fairer to retain their services as consulting engineers at once; if their suggestions were superfluous, why were they permitted to waste their money and energy in offering them? Of course the engineers of the Commission feel in duty bound to earn their respective salaries; but there is something grotesque, to put it mildly, in calling in the services of a considerable body of competent men and then quietly dropping them overboard. It is reported that two or three consulting engineers have been secured by the Commission, and perhaps it might be thought that they were selected from among the most distinguished of those who had proffered their services; on the contrary, they were outsiders, of high reputation in their respective lines of work, but none of them in the least degree well known as designers of underground work of any character whatsoever, unless, possibly, the foundations of a bridge. We shall await with interest the plans that have been evolved by this peculiar process of free instruction.

The Edison Convention. THE annual convention of the Edison illuminating companies has just been held in this city, and from a report published elsewhere in our columns, we judge that the proceedings were of more than usual interest, but we regret to say that the unfortunate policy pursued by the association prevents us from making a report that will be of special interest to our readers, and, indeed, when the official report of the proceedings is finally made public it will probably have been so thoroughly edited as to be in a large measure robbed of its value. It is too bad that the secretive policy has obtained such a firm hold on electrical industry in this country; in the long run it does no good and makes no friends. If a company of whatever kind puts out thoroughly good and reliable electrical apparatus that gives good results in practice, it should have no fear of allowing the facts to be known. If, on the other hand, reports are unfavorable, it is far better policy to improve the apparatus in the directions indicated than to suppress the facts and continue the old policy. A man who buys electrical machinery will feel more secure in its use and will operate it with more uniform success if he is allowed to profit by the experience of others; if not, and he meets with difficulties, his feelings toward the company of which he has purchased will be anything but pleasant. Of course it is almost too much to expect that any large commercial concern will willingly disclose the weak points of its products, but surely the user need not be tongue-tied, unless indeed he is completely under the control of the parent company. It would certainly tend to improvement, both in theory and practice, if the facts were made public instead of being in part suppressed by the censorship of those who are interested in keeping all valuable details a profound secret. The Edison company is not alone in this policy, on the contrary it is quite too generally adopted; it is only on some such occasion as the meeting of the New York State Street Railway Association at Rochester last year, when tongues were loosened in debate, that cold, uncompromising facts are disclosed.

The Periodic Law and Tensile Strength. WE publish elsewhere a very striking paper, by Mr. Reginald A. Fessenden, dealing with a subject that is of profound theoretical interest—the correlation of the physical properties of metals. Some time ago it was clearly shown by Mendelejeff, and his scarcely less distinguished contemporary, Lothar Meyer, that the chemical properties of the elements were connected in a most marvelous way, so that all the elements, metals and non-metals alike, could be formed into a number of groups, the properties of each of which were singularly alike, but showing a regular progressive change from one group to another, and from each member of any group to the next. So perfectly were the chemical facts related that knowing two or three members of any one group it was possible to predict with great exactness the chemical behavior of any other member of which the atomic weight might be known. Not only this, but since between all the atomic weights there were systematic relations, it became possible to predict the atomic weights and chemical characteristics of some missing member, a metal as yet unseen by human eyes. There are two very striking verifications of such scientific prophecies: one the discovery of the rare metal gallium, in 1875; the other that of the still rarer metal germanium some four years ago. The physical properties of the elements, too, have been in a certain way found to bear relations to each other, but of a character very much less definite than those alluded to. Mr. Fessenden has been investigating especially the mechanical properties of the metals used in the arts, and has worked out some very beautiful relations between the atomic volume of an element, its tensile strength and other physical characteristics. They are, of course, only approximate, but sufficiently close to show plainly enough that the relation exists and may be readily depended upon. All this may not, at first sight, seem to have any direct bearing on electricity, but Mr. Fessenden goes on further to show that by considering any two consecutive layers of atoms in a metallic bar as condenser plates charged to a degree such as is equal, roughly speaking, to the contact differences of potential as they can be best determined, the attraction between these layers is so nearly equal to the tensile strength of the material as to be strikingly suggestive. Of course, the weak point in the argument is the uncertainty of what are, perhaps, incorrectly known as contact differences of potential. Still it is a very interesting fact that the force between two such molecular condenser plates should be even of the same order of magnitude with the known tensile strength; it at least hints that either the hypothesis of electric charge upon the molecules is justified, or, what to us seems more probable, that the inter-molecular forces are just about sufficient to account for the particular sort of strain that we know as electrical charge. At all events the extraordinary relations between the most familiar physical properties of the elements, shown by Mr. Fessenden's work, are of immense interest in themselves, and the field is one in which investigation will be richly repaid.

Latest Foreign Electrical News.

(By cable from our Own Correspondent.)

London, Aug. 17, 1891.—The annual meeting of the British Association for the Advancement of Science at Cardiff, which will open on Aug. 19, will be characterized by nothing very startling in the electrical line. Mr. W. H. Preece will read another paper on the London-Paris telephone line and its operation; Prof. S. P. Thompson will discuss the effects of tempering on the magnetic qualities of steel; Mr. Swinburne will read a paper on standard cells; and Prof. Robinson one on petroleum engines. Prof. O. J. Lodge will conduct Section A, mathematics and physics, in which the most of these will be read.

The Liverpool Electric Railway, which will be conducted on the trolley system, has entered into a contract with the Electric Construction Corporation to run trains by electricity at a cost of not over 7 cents per mile for locomotive expenses. This is the same guarantee as was offered in the case of the City & South London Railway.

The great electrical exhibition which it has been proposed should be held in the Crystal Palace has been postponed until January, in deference to the expressed wishes of the electrical section of the electrical and allied trades.

The secretary of the Society of Arts will start for Chicago in September in order to look after the interests of British exhibitors at the exposition.

Owing to the very large amount of sharp criticism that has been offered in regard to the municipal plants at Glasgow and Cambridge the question of the system to be employed has been completely reopened; it has been the cause of much wrangling from the very start, and is apparently no nearer settlement now than it was some months ago.

A curious accident is reported from the Lichterfeld Electric Railway, which, as your readers will probably remember, is the oldest practical electric railway in existence, running from Berlin to Lichterfeld, one of its suburbs. The car suddenly stopped, midway of its passage; no help was near, and the conductor, after exhausting his ingenuity to start it, had turned back toward the station to secure assistance, when the car bolted homeward and ran off the line at the terminus with considerable violence.

Formal complaint has been entered by those most interested in maritime affairs, coming directly from navigators, against the glare of the electric lighthouses at various points along the channel, and the use of colored lenses throwing vertical rays is suggested. Mariners usually have objections to the electric light, on account of the difficulty of seeing readily beyond it, and such action has been threatened for some time. The suggestion for a remedy is a rather happy one, as the vertical beam is readily seen from a long distance, and does not create any glare that would interfere with the visibility of objects beyond the range of its immediate illumination.

Notes on Telephone Cables.

BY FREDERIC A. C. PERRINE.

I regret that my correction of the mathematical errors in my "Note on Telephone Cables" did not reach the editor's desk in time for insertion in the last number of The Electrical World; however, as I stated in my letter of Aug. 8, the errors were not ones of knowledge, but of calculation, and, in the case of the statement of Mr. Preece's constant, one of memory.

The method I used in comparing different cables to a pole line was to assume a definite line, constructed of 12 B. & S. hard drawn copper wire, strung on poles 36 feet in the air. The resistance of such a line would be approximately 8.448 ohms per mile, and the capacity, according to Prof. Jacques' table, .0115 microfarads per mile, giving, accordingly, a K R of .09715 per mile. If now a cable of 36 ohms per mile and .3 microfarads capacity be assumed, the K R will be 10.8, which is the equivalent of 10.5 miles of the assumed pole line.

As regards the Roebling cable laid in New York, Mr. Webb impugns my honesty in stating the resistance, but I hardly think that I am to blame for taking the figures given in my notes, since the only report sent me on this cable is one countersigned H. L. W., giving the average capacity as .076 per mile and the average conductor resistance as 32.83. I incidentally heard that this report was in error, the length having been taken from a memorandum bill of the total length of cable shipped, and that a recalculation of the length brought the capacity to .081, this corresponding closely with the factory tests as well as those of an accurately measured cable laid in Boston manufactured at the same time I thought warranted me in taking the conductor resistance as 33.6, the Boston measurement.

In getting the electrical measurements on this cable one of Mr. Webb's assistants, being troubled with a certain amount of vibration at the place where his galvanometer was set up, succeeded in obtaining an accurate constant on the mantlepiece at his home after the day's work was done, and knowing this I do not think that I was very rash in assuming the Boston measurements together with the factory test as likely to be an accurate result on this cable.

I would like also to call Mr. Webb's attention to a slight error he has made in calculating the K R of 736 miles of cable having a resistance of 33.6 ohms per mile, and a capacity .082; as I calculate this the total resistance would be 24,729.6 ohms and the total capacity 60.352, or a K R of 1,492,480.8192, about 13 times as great as his result, 112,700.

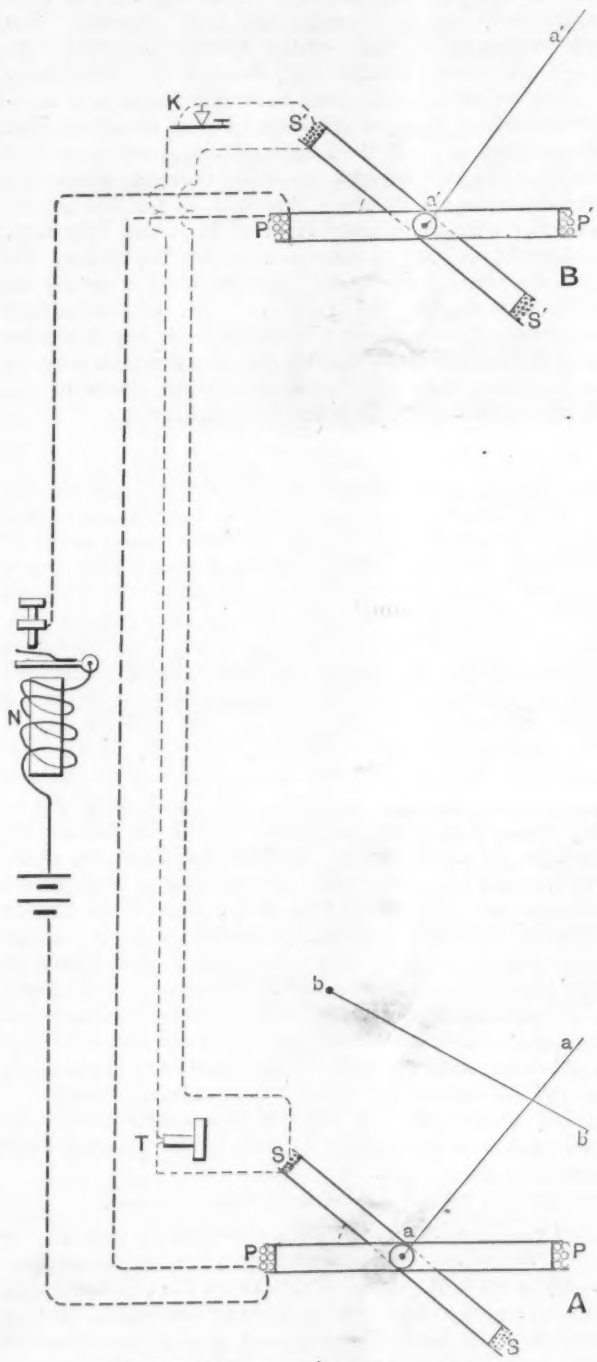
A New Form of Range Finder for Use with Modern Seacoast Guns.

BY LIEUT. GEORGE L. ANDERSON.

The modern seacoast gun is an expensive piece of machinery to construct and operate. As employed in our harbor defences or on board the new naval ships, it serves to fire, as a rule, not more than 300 pounds. The wear and tear on the gun and its carriage, the original expense of the projectile, charge and minor items make, in these days, the cost of delivering a single projectile by any powerful and self-respecting nation about $450. Economy alone suggests, therefore, that the piece shall be carefully aimed, and that means must be found to ascertain quickly and accurately the distance to the object—fixed or moving—aimed at.

A still more important consideration is effectiveness of fire. Future operations are destined to be short and decisive owing to the improvements in material, so that exact knowledge of the enemy's position at the outset and during the fight will be more strongly demanded than heretofore.

Artillerists have accordingly sought to devise some method of ascertaining readily, and so far as practicable automatically, the bearing and distance of any desired object—fixed or moving—from the gun, or of locating its position in some simple manner upon a chart of the harbor or other field. Such a method, if simple, would also prove serviceable to them in operating submarine mines. The result has been a great variety of range or position finders, to be found now for the most part in the museums or the scrap heap.



A New Form of Range Finder.

An effective method, early employed on land, consisted in placing at the extremities of a suitable base line two azimuth instruments, by means of which the angles to any given object were measured. The readings were then signalled to the persons at the gun, who plotted the courses on a map of the harbor and thus located the object. A scale of the map gave the required distance, and, when the signaling was performed by telegraph, the whole operation occupied less than one minute's time. The plan when carefully conducted was found in every day practice to locate any position with sufficient accuracy. Yet the precision depends upon the skill and coolness of each of a half dozen persons, and it is not thought the method would find much use in time of war.

To render as far as possible the foregoing method automatic, the Siemens Brothers brought out several years ago their "distanzmesser" in which two light horizontal arms 20 inches long swept over the map on the plane table—each one keeping constantly parallel to the axis of the telescope with which it was connected electrically. Either arm was moved by the usual step by step contrivance driven by currents induced by a magnet, whose motion turned the telescope. If the telescopes at the ends of the base lines were continually directed upon a moving vessel in the harbor, the two arms of the plane table turned with them and by their intersection indicated the vessel's position on the map in a continuous manner. Only two observers were required, and the system was sufficiently automatic. But the apparatus, finely executed like all the Siemens' work, was costly, complicated and easily disarranged. The failure of either arm to remain parallel to the axis of the telescope was not easily discoverable.

Other range finders on the Siemens principle using the make and break direct current or the induced have been tried, but they have proved too complicated, expensive and uncertain in action.

The Watkins range finder adopted in the British service is essentially a depression instrument requiring a vertical base line not always obtainable, a correction for the height of the tide and a clear view of the water line on the vessel, which would frequently be hidden in smoke.

The Austrians use the camera obscura, which requires only a single observer, and which is so simple as to suggest its employment in this country as a check upon whatever better method may be adopted to locate objects in our harbors.

Of all the various devices thus far suggested, the range apparatus of Lieut. A. B. Fiske, U. S. Navy, is most original and interesting. It is constructed and operated upon the plan of the Wheatstone bridge. There is no complicated mechanism to adjust, and it is fairly accurate within a large range of distances; it can be manufactured cheaply, it will withstand the rough usage of service, it requires a short base line and seems to be admirably suited to service on board ship. Several Fiske range finders have already been purchased for the government service.

The resistance of the arms of the bridge is small, and and yet we have not heard that there is a liability to error or uncertainty in the readings of the instrument, due to slight changes in the connections between the arms or to unequal heating or slight injury to the bridge wire. The inventor has, doubtlessly, considered the advisability of using larger resistances in the arms by replacing the slide turn of the bridge by a great number of small resistances joined in series and allowing the slider to move over the usual brass contact pieces.

A new form of range finder, which is here proposed, involves the principle of the Hughes induction balance as modified in the teleinductor. Balance is obtained by a motion of rotation instead of translation. It has no delicate mechanism, and it dispenses with the troublesome galvanometer. It is, moreover, simple, inexpensive, and may be brought to as high a degree of accuracy as may be desired. A full description of the instrument is not given, but the principle of its construction will be readily understood by all interested in the subject from the accompanying diagram:

PP and *SS* are primary and secondary coils, respectively of circular or other form, located at station *A*, one extremity of the base line. One coil has a smaller diameter, so that it may revolve inside the other about a vertical axis, lying in the planes of both. *SS* may, therefore, occupy any position from 0 degrees to 90 degrees to *PP*. *aa* is a light pointer attached to *SS*, perpendicular to its plane, and moves with it over the face of the map, which for simplicity of description we shall suppose in this case to be located at station *A*. At station *B*, the other end of the base line, *P'P'* and *S'S'* are respectively primary and secondary coils similarly constructed to those at *A*, or so made as to have the same coefficient of induction. *A'A'*, perpendicular to the plane of *S'S'*, is the axis of a telescope, whose motion in azimuth carries, in the case here shown, coil *S'S'* with it.

The two primaries *PP* and *P'P'*, whose planes are kept parallel to each other, a battery and a buzzer are joined in simple circuit, as shown. The two secondaries *SS* and *S'S'*, a telephone at *A*, and a closed key, *K'*, are connected in simple circuit in such manner that the current induced in the secondary at *A* is opposite to that induced in *S'S'* at *B*. It is evident that whenever coil *SS* is moved by hand to occupy a position parallel to *S'S'*, the buzzer being set in operation, all noise in the telephone will cease and the observer at *A* will know that the pointer *aa* is parallel to the vertical plane through the telescope axis *a'a'*.

bb is a pointer like *aa* sweeping over the surface of the map and keeping parallel with the motion in azimuth of the axis of the telescope *ab* *A*, with which it is connected mechanically. The point on the map where *aa* and *bb* cross will then represent on the map the object in the harbor to which the telescopes at the ends of the base line are directed, if we may suppose the surface to be a plane area.

The secondary at *A*, as here described, should be made to revolve from 0 degrees to 90 degrees in the same direction, as at *B*. Both secondaries may, however, revolve from 0 degree to 90 degrees in the other direction if the observer at *B*, by means of key *K*, so signals to *A*. The best positions are from 45 degrees on one side to 45 degrees on the other, and these may be used if 90 degrees give sufficient range, as would be the case in most instances.

The battery power may be all that the contact points of

the buzzer will admit, and therefore considerable. Two telephones, having the lightness and distinctness of instruments manufactured abroad, should be employed. These are connected with each other by a metal strap which holds them tightly to the ears of the observer at *A*.

Two observers only are actually necessary. Three or four observers and essentially a duplicate of the plant above described will be required if the map is desired at any point other than the extremity of a base line.

To simplify the description four wires are here shown connecting *A* and *B*. In practice it will be found preferable to ground one of the circuits so that three wires serve equally well. Or if both circuits are grounded two wires only will be required.

The object of this article is to show how readily the induction balance lends itself to locate the position of a distant object at sea rather than to give a complete description of the instrument.

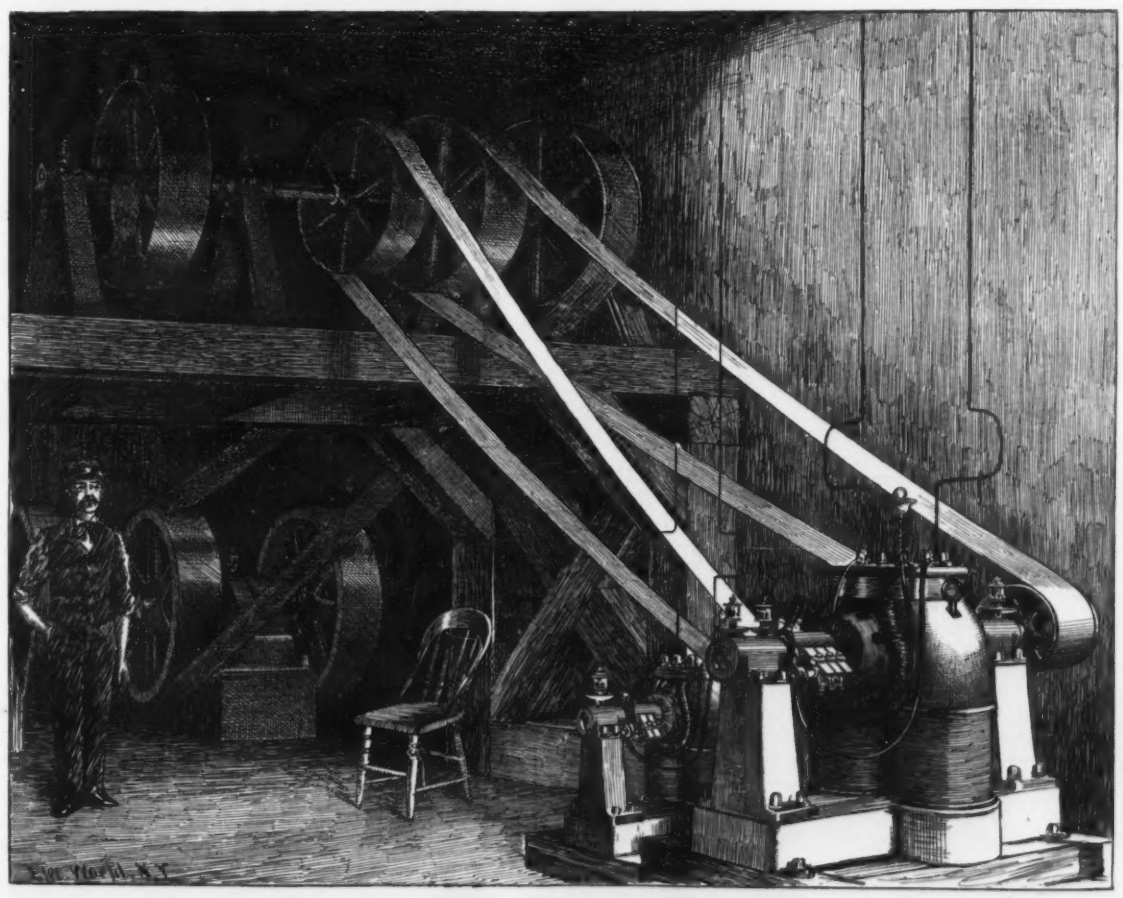
Electrical Laboratory, U. S. Artillery School,
Fort Monroe, Va.

Electric Lighting in the Church of Notre Dame.

In taking in a view of the city of Montreal from the beautiful mountain at its back or from the river at its feet one of the most prominent buildings and one which seems to first catch the eye is the Church of Notre Dame, with its two high and imposing towers. No visitor in that quaint old town has come away satisfied without having ascended one of these towers, and viewing the great bell which they are told is the largest swinging bell on the Continent.

The church shown in Fig. 1, which is the most elaborately decorated of any church in Canada, is wired for 400 incandescent lights, and these lights have all been arranged to the very best advantage. One hundred and fifty are placed around the alcove that contains the altar, and being hidden from view shed all their light directly on the altar with its dozens of golden pinnacles, each surmounted by a tiny incandescent lamp, and altogether making the most gorgeous spectacle that can well be conceived. The plant that furnishes the light is placed in a convenient place just beneath the altar, and consists of one 300-light and one 100-light Royal Electric Company's (of Montreal) machines driven by one 60-h. p. Waterbury engine, there being another duplicate engine in reserve. Two Babcock & Wilcox boilers are installed in the basement at a convenient distance from the dynamo room. As seen in Fig. 2 the dynamos are belted from a countershaft placed on a trestle or bridge. This was found necessary to avoid the vibrations that would have naturally occurred with a hanging shaft—a shaft being necessary on account of the precaution against accident in having two engines each ready for use in case of any trouble with the other. The plant will no doubt be examined by the visitors to the coming convention with considerable interest.

Notre Dame Cathedral, Montreal, Can.



ELECTRIC LIGHT PLANT IN THE NOTRE DAME CATHEDRAL, MONTREAL, CAN.

The Rockford (Ill.) West End Railway.

The West End Railway Company, at Rockford, Ill., is operating the Short system on two lines of 2¼ miles each, which were opened to the public on June 3. Three motor cars and three Stephenson trail cars are only used at present, the motor cars carrying two 15-h. p. high speed Short motors, but the additional motor cars will be equipped with the Short gearless motor. The road contains several curves and two grades of 4 per cent. and 6 per cent. respectively. Sawed 6″ × 6″ white oak ties, laid 2 feet apart, support 48-pound girder rails in the business portion of the city, and 35-pound T rails near the outskirts. The pole line presents a handsome appearance far above the average and would be a credit to any street in the larger cities. Both lines run to the baseball grounds, and on July 4 there were 178 passengers carried at one time on a motor and trailer without the slightest difficulty being experienced. The installation was supervised by Mr. W. J. Davison, of the Short Electric Company. The company has an 80-h. p. Short generator and an Ideal engine of 150-h. p. that are being operated in the station of the Forest City Electric Light and Power Company until the question of a new power house is decided. The completion of this line has materially added to the value of suburban property, and it is reported that contracts for 14 new buildings have been let, and that several new factories will be built now that the western section of the city has such excellent rapid transit facilities. The officers of the company are Mr. J. S. Ticknor, president, and Mr. F. A. Ticknor, secretary and treasurer. These gentlemen are energetically pushing the work of the company.

Atomic Volume and Tensile Strength.

BY REGINALD A. FESSENDEN.

If we examine an ordinary table of tensile strength, such as is given, for instance, in any Engineer's Pocket Book, there is no apparent relation between the tensile strengths of the metals as given there.

This is only what might have been expected. In the first place the materials are not arranged in any natural order, and we could hardly expect to find a relation between the tensile strength of two such dissimilar substances as wood and iron, an element and a highly complex organic compound. In the second place, the materials tested are not pure, they are simply the ordinary substances as they are used in practice. In the third place, the tests were probably made from pieces of different diameters and the results reduced to a common section, usually one square inch. This, of course, renders them worthless, as to take an example, quartz in the form of the fine threads produced by Mr. Boys has a tenacity equal to that of good steel, when the results are reduced to breaking strain per square inch. We have then, first, to choose the materials we purpose to find a relation between. We will confine ourselves to the simple elements and, as we shall see below, to one particular group of these.

If we take the curve of the elements given in Fig. 1, and wrap it round a four sided piece of wood, whose sides are marked *N S E W*, we see that the elements on each of the four sides have very distinct properties, the metals coming on sides *N* and *S*, and the metalloids on sides *E* and *W*. Moreover, as all the metals which are used for ordinary purposes in the arts come on side *S*, we will call them the "Metals of the Arts." Those on side *N* we will call the "Metals of the Earths." The metalloids on side *W* we will cell the "Primary Metalloids" as being produced for their own qualities, and those on side *E* the "Secondary Metalloids" as being chiefly used in processes for producing other things.

As the only data obtainable are those relating to the metals of the arts, we will confine ourselves to them. They are:

Iron, cobalt, nickel.
Ruthenium, rhodium, palladium.
Platinum, osmium, iridium.
Sodium, copper, silver, gold.
Magnesium, zinc, cadmium, mercury, aluminium, gallium, indium, thallium, silicon, tin, lead.

If we take the results given for the tenacity for these metals we must apply three corrections: First—Value must be given to the results in proportion to the standing of the observer, much more weight being given to the results of a man who appreciated the fact that iron is a rare element than to those of a man who considered iron to be a thing you can get almost anywhere, the main thing being a judicious use of higher mathematics. (A friend of mine has a theory that no work is wasted. This may be true, but if there is such a thing as worthless work it is that of the scientist who experiments to seven places of decimals on materials other than chemically pure.)

Second—Deductions must be made for what impurities are likely to have influenced the result. If several results can be got with metals with different quantities of impurity, a curve may be drawn showing the probable value for the pure metal. For instance, if iron with .5 carbon has a breaking strain of 65 kilos. per millimetre and iron with .3 carbon has a breaking strain of 50 kilos. we may suppose that the breaking strain of pure iron is about 40 kilos.

Third—Allowance must be made for the difference in size of the materials tested.

If we make these allowances we obtain results which show plainly that there is a relation between the tensile strength of metals. The mean results come very close to those obtained by M. Wertheim, and which are given in an article by M. C. Decharme in *La Lumière Electrique* for Jan. 11, 1890. These results, from experiments most carefully made, give as the breaking strain for wires one millimetre in diameter the following figures:

Metal.	Kilo.
Iron	65
Copper	41
Platinum	35
Silver	29.6
Gold	28.46
Zinc	15.77
Tin	3.40
Lead	2.36

These figures are very suggestive, for they follow the order inversely of the atomic volumes of the metals. There is one exception, zinc and lead and tin are too small, but if we multiply the weights given by the alligation, or number of atoms in the molecule, this number being, except in the case of iron, identical with the valency, we then get the numbers given in column II.

Some weeks after an article on the same subject, and containing the data and deductions here given was written and forwarded for publication to *Nature*, a paper on Rigidity, by Mr. Sutherland, appeared in the *Phil. Mag.* for July. As the results obtained by him (though made only with the purpose of proving the law of variation of rigidity with temperature, and though he saw no relationship between the values for the different metals), agree extremely well with the theory described in the present paper, I have given them in column III.

It will be seen that in both II. and III. the values for tensile strength and rigidity decrease regularly as the atomic volume increases. (The atomic volume being the quotient of atomic weight by density, represents the relative sizes of the atoms.)

The reason for introducing the alligation is as follows, briefly: Metals are capable of existing in various allotropic forms, as the conditions vary. Each form probably differs in having a different number of atoms in the solid state. Sulphur, which we know forms in many allotropic states, has, in one state at least, six atoms to the molecule. Ozone is the union of three oxygen atoms. There are many other instances.

Zinc, when heated, exhibits very peculiar behavior. At ordinary temperatures it is brittle, as the heat is raised to 150 degrees C. it becomes very ductile. If the heat is raised still more it becomes as brittle as glass. It is only reasonable to suppose that we have here another instance of allotropy, and since the valency is 2, that there are two atoms in the molecule. Therefore there will be only half as many mole-

cules in the cross section of the wire, and so the breaking strain will be diminished to one-half.

Similar considerations apply to tin and lead.

I. Metal.	II. Tensile strength.	III. Rigidity.	IV. Atom. etc.
Iron	42 (Ostwald)	750	7
Copper	41	430	7.1
Platinum	35	...	8.7
Zinc (15.77 × 2)	31.5	350	9.2
Silver	29.6	280	10.2
Gold	28.46	270	10.2
Aluminium (10 × 3)	30 (Minet)	250	10.4
Magnesium	..	150	14
Tin (3.40 × 4)	13.6	135	16.2
Lead (2.36 × 4)	9.4	84	18.2

If the atoms are at any considerable distance from each other in the solid state, it is not probable that their volumes should have much influence on their physical states, and it may be argued that there are several reasons for supposing that the atoms are not near each other in the solid state. (By near is meant that the distance between two atoms is small as compared with their diameters.) One reason is the absorption of large quantities of gas by apparently solid metals, with but small increase in bulk. But in such cases there is every reason to believe that the gases are in the liquid or even solid state.

A much more potent argument is the fact that two solid substances may combine to form a compound which has less volume than either separately. For instance, 39 parts of potassium, having a volume of 45 cubic inches. combines with 35.5 parts of chlorine to form K Cl, which has a volume of 37 cubic inches only. At first sight this would seem to prove decisively that the atoms of potassium are not near together, for it shrinks 20 per cent. on taking up a nearly equal weight of another substance. But here again, by collecting data, we find the solution. This phenomenon only occurs when elements of large atomic volume such as sodium, potassium, rubidium, and calcium, having the large atomic volumes of 23.5, 45, 56 and 70, combine with substances having comparatively small atomic volumes, such as chlorine and oxygen, and the phenomenon resembles the mixing of a bushel of peas with a bushel of billiard balls. To take a particular example: Suppose potassium atoms, having an atomic volume of 45.5, to have the position *A* in Fig. 2, their kinetic energy driving them apart, so that they are as far apart from each other as possible, yet still nearly touching one another, as they are still in the solid state. It is easy to show that if the added chlorine atoms have an atomic volume of 17 they will just fit into the spaces *S S* between the potassium atoms, and if they have a volume of less than 17 their attraction will draw the potassium atoms over into the positions shown in position *B*, thus making the potassium and chlorine atoms together occupy less space than the potassium alone.

The atomic volume of chlorine in the liquid state is 24. But all the "permanent" gases expand very rapidly at temperatures between their normal boiling point and critical temperature, though under sufficient pressure to keep them liquid. $C O_2$, for example, expands 50 per cent. in volume between $-20°$ and $+30°$ C. There is thus a great degree of probability that the atomic volume of chlorine is less than 17 in the solid state, so that the shrinking of volume of K Cl is no proof that the atoms are not close together.

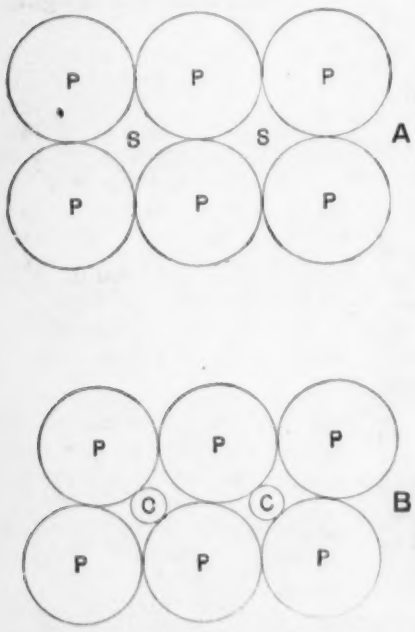


FIG. 2.—STUDY OF TENSILE STRENGTH.

the fourth power of the atomic radius, or as the $\frac{1}{4}$ power of the atomic volume.

Fig. 3 is a curve drawn with the ordinates as breaking strain in kilos. and the abscissæ as atomic volumes. The full line gives the values actually obtained, and the dotted line shows the calculated values from the equation.

$$T = \frac{550{,}000}{\text{alligation} \times (\text{atom. vol.})\,\frac{1}{4}}$$

Fig. 4 is a curve drawn in a similar manner, with the exception that for tenacity is substituted rigidity. As this varies as the number of atoms, the square of their distance

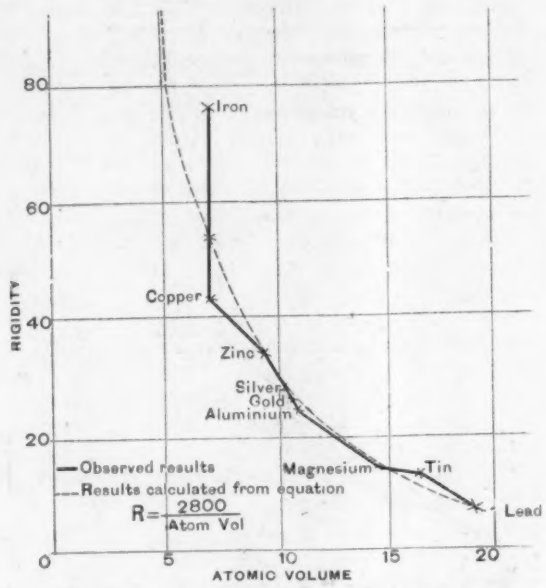


FIG. 4.—FESSENDEN'S STUDY OF ATOMIC VOLUME AND TENSILE STRENGTH.

and the number of atoms in the length of the wire, it will be proportional to the $\frac{6}{4}$ power or square of the atomic volume, and the equation for rigidity is given by

$$R = \frac{2800}{(\text{atom. vol.})^2}.$$

The full line shows the observed values from Mr. Sutherland's paper, and the dotted line the calculated values.

(The square of the atomic volume varies as the sixth power of the radius, *i. e.*, as the sixth power of the distance between the atoms. This is suggestive when one recalls the results Quinke arrived at, in his work on capillary tension, etc., and Vander Waals' equation for the compression of gases, $\left(p + \frac{a}{v^2}\right)(v - b) = R\,T$, also appears to be a particular case of the action of this force.)

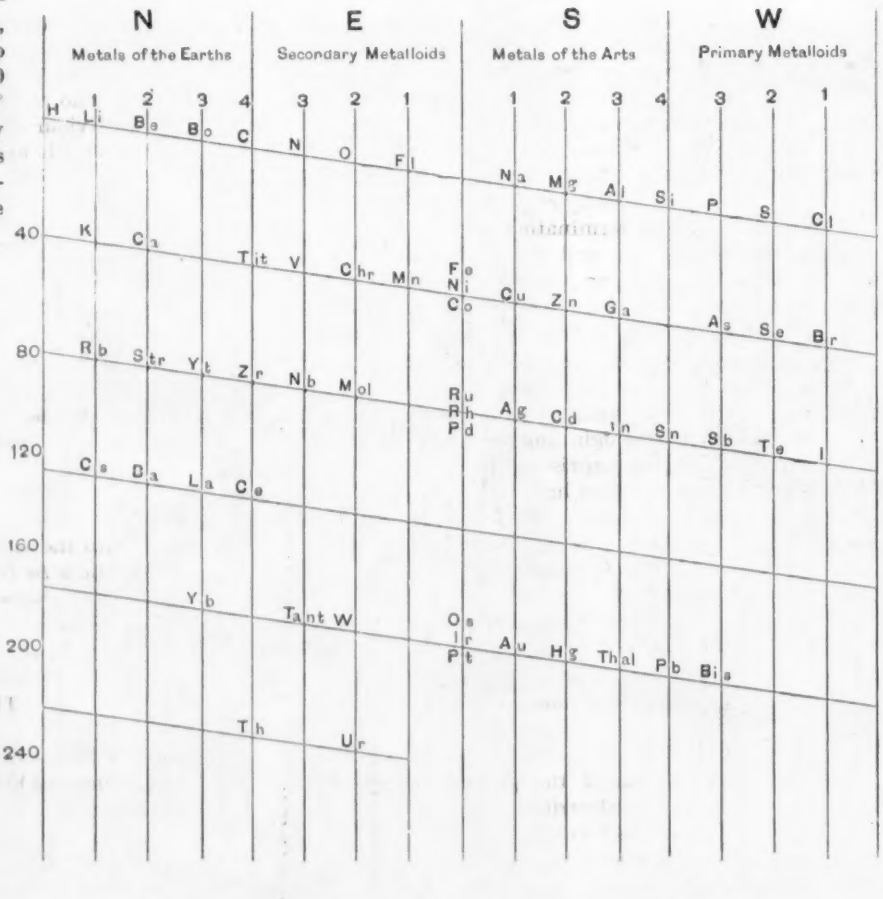


FIG. 1.—STUDY OF ATOMIC VOLUME AND TENSILE STRENGTH.

energy, velocity of motion, size and distance apart, it only requires a knowledge of the force holding them together to make the physical properties of matter merely dynamical problems.

It is evident that this force cannot be gravity. In the first place it is much too small, as may be easily calculated. In the second place it does not vary as the weight, but as the number of the atoms, so that no theory based on assumption of the effect of gravity on bodies of different shape can hold. Third, the force of an atom does not extend beyond its immediate neighbors.

We can get an idea of the force in the following way, as stated in a previous article:

Suppose a number of soap bubbles of the same size be electrified equally and then caused to shrink to different sizes. As they shrunk the potential would grow larger. If we suppose two small bubbles of radius 1 placed close to one another, then, provided they were of opposite potentials and no redistribution of electricity on their surfaces occurred, they would attract each other with four times the force of two bubbles of twice the radius, *i. e.*, the force would vary as the square of the distance between their centres, and a rod made up of such bubbles would obey the same laws as rods of the metals actually do.

Electrostatic attraction is quite competent to produce effects of the same order as those observed. We may look on the two fresh surfaces of a broken wire as the two plates of a condenser. To obtain the attractive force we must know the distance between the plates and the voltage. For a first rough approximation we may look upon the charges of the atoms as being concentrated at their centres. We may then suppose a wire to be made up of a number of very thin discs, each disc being a layer of atoms. Any two of these layers we may look upon as the two plates of a condenser, and their centres will be separated by a distance equal to the diameter of the atoms.

We know the diameter of the atoms very nearly to be between 10^{-7} and 10^{-8} centimetres. Let us take a metal with small atomic volume—say silver, atomic volume 10. As it is one of the smaller atoms we will call its diameter 10^{-8} centimetre.

As the atomic diameter varies from 2 to 3, and with it, according to the theory given above, the voltage; as the greatest contact E. M. F. is about $\frac{1}{4}$ volt, we may call the potential of the atoms about 1 volt.

The attraction of two plates 1 square centimetre in area, at a potential of one volt, and at a distance of 10^{-7} centimetres, will be:

$$\text{A} \qquad \frac{4.508 \times 10^{-10} \times (1)^2}{10^{-16}} \text{ grammes}$$

= 4,500 kilos. per square centimetre,
= 45 kilos. per square millimetre;

or, with somewhat unnecessary refinement, 33 kilos. for a wire one millimetre in diameter.

On looking at the table it will be seen that the value given for a wire of silver one millimetre in diameter is .29 kilo., almost exactly that calculated from the electrical theory.

If these layers of atoms are at the given distance and are at the given potential they will have a capacity per square centimetre area of

$$\text{B} \qquad \frac{1}{1.131 \times 10^{13} \times 10^{-8}} = 10^{-5} \text{ coulombs.}$$

This is very nearly the known capacity of such a

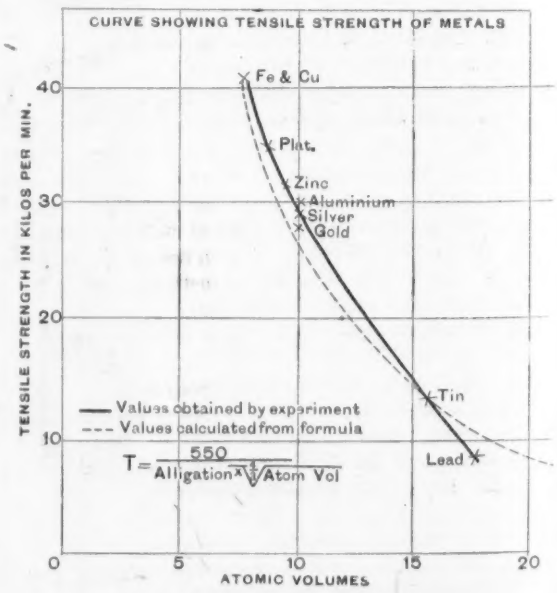


FIG. 3.—STUDY OF TENSILE STRENGTH.

From the figures in column II., the force causing tenacity does not appear to vary directly as the atomic volume or the atomic radius. It is natural to try if it varies as the square of the atomic volume.

If tenacity were caused by a force varying inversely as the square of the atomic volume, the tenacity of two similarly sized wires of different metals would not vary in the same ratio, for the tenacity of a wire varies in two ways: first, directly as the number of atoms in the cross-section of the wire, *i. e.*, as the square of the atomic radius; second, as the square of the distance of the centres of the atoms from one another, *i. e.*, again, as the square of the atomic radius. The strength of the wires will vary then as

The facts stated above seem to show beyond reasonable doubt that there is a force acting between atoms, which varies inversely as the square of the distance between their centres, and that this force, which I will call the equivalent force of atoms, is able to account for the phenomena of cohesion and rigidity. By its assumption, formulæ have also been obtained by the author for other physical phenomena, *i. e.*, expansion, melting point and conductivity—in fact its assumption places us almost in the same position in regard to the prediction of the physical properties of matter that the assumption of the force of gravity does to the prediction of the movements of the planets. For, since we know the weight of the atoms, their kinetic

layer. For one coulomb of electricity electroplates 1.118 milligrammes of silver. A cubic centimetre of silver weighs 10.5 grammes, and its atoms have a capacity of, therefore, $\frac{10{,}500}{1.118} = 10{,}000$ coulombs nearly. The cube may be supposed, as before, divided up into thin plates. As the diameter of the atom is 10^{-8} centimetre, there will be 10^8 layers, and each layer will have $\frac{10{,}000}{10^8} = 10^{-4}$ coulombs, (C), very nearly that found above in B. If this is a coincidence it is a remarkable one.

From the formula A we see at once why the tenacity for a wire should vary as the $\frac{1}{4}$ power of the atomic volume in-

versely. For the attraction varies directly as the square of the voltage, *i. e.* (since the voltage varies inversely as the radius), inversely as the square of the atomic radius. The attraction also varies inversely as the square of the distance between the plates, *i. e.*, again, inversely as the square of the radius. Therefore, the whole attraction varies inversely as the fourth power of the radius, *i. e.*, as the $\frac{4}{3}$ power inversely of the atomic volume. Therefore, since the electrostatic attraction has been found to give a correct value for one metal, *i. e.*, silver, it will give correct values for all.

Thus we see that electrostatic attraction is fully competent to produce the observed results, that if we calculate the probable value of the attraction from the known sizes of the atoms and their most probable potentials, we find it to be almost exactly that actually observed, and that the capacity of two such layers of atoms under such circumstances is almost exactly what we know from the phenomenon of electrolysis to be their actual capacity. Lastly, that the equation arbitrarily determined for the tenacity of metals is exactly what is deduced from the electrostatic equations.

It is needless to say that the distribution of electrostatic charge must differ from that given above; but the subject is a rather complicated one, therefore the above results are only given as a first approximation.

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Chronological History of Electricity, Galvanism, Magnetism and the Telegraph, from B. C. 2637 to A. D. 1888.—Part I.*

BY P. F. MOTTELAY.

A. D. 1753.——Beccaria (Giovanni Baptista), a very ingenious and industrious Italian electrician and astronomer, is the author of several quite important works on electricity, aside from those named at foot, which are embraced in the list made up under the A. D. 1800 date.

Father Beccaria, as he is sometimes called from having been a member of the religious order of the Pious Schools, proved to be the most indefatigable follower of Franklin in the study of atmospheric electricity. He was the first who diligently studied and recorded the phenomena of thunder storms, and his many observations thereon are detailed by Priestley throughout part I., period X. and section X. of his great work on electricity. Beccaria considers that all clouds, whether of thunder, rain, snow or hail, are formed by the electric fluid; that the electric matter is continually darting from the clouds in one place at the same time that it is discharged from the earth in another; and that the clouds serve as conductors to convey the electric fluid from those places of the earth which are overloaded with it to those which are exhausted of it.

Having shown for the first time that the polarity of the magnetic needle is determined by the direction in which the electric current has passed through it, he suggests taking the polarity acquired by ferruginous bodies as a test for ascertaining the kind of electricity with which the thunder cloud is charged.

He also shows that the meteor called a *falling star* is an electrical appearance. He explains the cause of the peculiar noise which attends the electric spark. He states that the passage of electricity is not instantaneous through the best conductors, having found the effect of a spark to occupy at least half a second in passing through 500 ft. of wire and six and a half seconds through a hempen cord of the same length, although when the latter was dampened it passed through it in two or three seconds.

He was the first to show the electric spark while in its passage through water, by discharging a shock through wires that nearly met in tubes filled with water, and he observed that the water sank in the tubes whenever a spark passed from one to the other as the air was repelled by the electric fluid. He found the effect of the electric spark upon water greater than the effect of common fire on gunpowder, and says he does not doubt that, if a method could be found of managing them equally well, a cannon charged with water would be more effective ("dreadful") than one charged with gunpowder.

Air contiguous to an electrified body is shown by him to gradually acquire the same electricity; also, that the electricity of the body is diminished by that of the air. He demonstrated that there is mutual repulsion between air and the electric fluid, and that the latter, in passing through any portion of air, creates a temporary vacuum.

The production of what he calls his *new inventive phosphorus* and the method he employs for *revivifying metals*, are described, respectively, at pages 365 and 282 of his "Lettere dell' elettricismo."

See, also, his "Lettere, etc.," Bologna, 1758, pp. 146, etc., 193, 266, 268, 290, 310, 345; likewise, his "Elettricismo Artificiale," Turin, 1753, pp. 110, 114, 227; and the *Phil. Trans.*, for 1760, pp. 514; 1762, p. 486; 1766, p. 105; 1767, p. 297; 1770, p. 277; 1771, p. 212; Wartmann, "Mém. sur les Etoiles filantes;" Humboldt, "Relation historique," tome I.; Lardner, "Lectures," vol. I., pp. 429–444; Sturgeon's *Annals*, vol. VI., pp. 415–420, 425–431, and vol. VIII., p. 180; Noad, "Manual," London, 1859, p. 197; Hale, "Franklin in France," Boston, 1888, part I., p. 447; Humboldt, "Cosmos," London, 1849, vol. I., pp. 99, 102–113, 197, 345, for the observations of Beccaria, Rozier, Kepler, Benzenberg, Brandes, Bogulawski, Nicholson, Arago and others on atmospheric electricity, aërolites, etc.

See, likewise, Beccaria's letters to Fromond relating his experiments tending to prove that electric motions do not occur *in vacuo*, also his letters to the Princess di Cariguano on the electricity of the moon, as well as to Signor Le Recoy and to Jacopo Bartolomeo Beccari relative to experiments with his kite; "Scelta d'Opuscoli," vols. XIX., XXI., XXXII; "Opuscoli Scelti," II., 378; III., 243, 284, 377.

A. D. 1753.——Bazin (Gilles Augustin), French physician and naturalist, publishes, at Strasbourg, an illustrated treatise on Magnetic Curves ("Description des Courants Magnétiques, etc."), which also contains his observations upon the magnet, and a supplement to which appears during the year 1754.

See "La Grande Encyclopédie," vol. V., p. 974; Michaud, "Biog. Univ.," vol. III., p. 353; Ninth, "Britannica," vol. XV., p. 242.

A. D. 1753.——C. M., *i. e.*, Charles Morrison and not Charles Marshall, of Greenock, Scotland, writes, from Renfrew, February 1, 1753, to the *Scot's Magazine*, a letter entitled "An Expeditious Method of Conveying Intelligence," wherein is first suggested a practical manner of transmitting messages by frictional electricity.

A full copy of this letter appears at pages 7–9 of Robert Sabine's "Electric Telegraph," London, 1872, and at page 9,103, No. 570, of the *Scientific American Supplement* for December 4, 1886, the last named also reproducing some correspondence establishing the identity of Charles Morrison which was found in the papers of Sir David Brewster.

In the article of Auguste Guérout, which appeared in *La Lumière Electrique* early in 1883, C. M. is alluded to as Charles Marshall. This is likewise the case in Johnson's Encyclopædia, 1878, vol. IV., p. 757. Fahie gives ("History of the Electric Telegraph," London, 1884, pp. 68–77) a full account of the many inquiries instituted to establish the identity of C. M., which he admits to stand for Charles Morrison, although, at page 81 of the same work, is given a letter of Sir Francis Ronalds alluding to Charles Marshall, of Renfrew. On the other hand, an article in *Cornhill Magazine*, vol. II., for 1860, pp. 65–66, speaks of an elderly Scotch lady who remembered a very clever man named Charles Marshall, who could make "lightnin' write an' speak" and who could "licht a room wi' coal-reek" (coal-smoke).

In his remarks upon the aforenamed letter, made during the year 1859, Sir David Brewster says: "Here we have an electric telegraph upward of an hundred years old, which at the present day would convey intelligence expeditiously, and we are constrained to admit that C. M. was the inventor of the electric telegraph. . . . Everything done since is only improvement."

See *Scots' Magaz.*, XV., p. 73; "Cosmos" of Feb. 17, 1854; *Athenæum* of Nov. 5, 1864; Lesage, at A. D. 1774; Du Moncel, "Exposé, etc.," vol. III., pp. 1 and 2.

A. D. 1754.——Diwish (Prohop), a monk of Seuftenberg, Bohemia, erects, June 15, 1754, a lightning protector upon the palace of the curator of Prenditz, Moravia. The apparatus, as described in *La Lumière Electrique*, was composed of a pole surmounted by an iron rod supporting 12 curved up branches and terminating in as many metallic boxes filled with iron ore and closed by a boxwood cover traversed by 27 sharp iron points which plunged at their base in the ore. All the system of wires was united to the earth by a large chain. The enemies of Diwish, jealous of his success at the court of Vienna, excited the peasants of the locality against him, and, under the pretext that his lightning rod was the cause of the great drought, they made him take down the lightning rod which he had utilized for six years and then imprisoned him. What is most curious is the form of this first lightning rod, which is of multiple points, like the one which Mr. Melseu afterward invented.

See *Poggendorff*, vol. I., p. 580, for Procupius Divisch's "Efand einen Wetter Ableiter," *Scientific American*, Sept. 10, 1887, p. 160.

A. D. 1754.——Ammersin (Reverend Father Windelinus), of Lucerne, Switzerland, announces in his "Brevis relatio de electricitate, etc.," that wood properly dried till it becomes very brown is a non-conductor of electricity. We have already mentioned the observation made by Benjamin Wilson (A. D. 1746) that, when a dry, warm piece of wood is broken across, one of the pieces becomes vitreously and the other resinously electrified.

Ammersin advises boiling the dry wood in linseed oil or covering it with varnish to prevent the possible return of moisture, and he states that wood thus treated seems to afford stronger appearances of electricity than does even glass. (*Phil. Trans.*, vol. LII., part 1, p. 342.)

See Ammersin, "Kurze Nachricht, etc.," pub. at Basel 1771, and translated the same year by Jallabert, who embodied it in his "Versuche über die Elektricität, etc."

A. D. 1754.——In his "Dissertations sur l'incompatibilité de l'attraction, etc.," Le Père Gerdil, professor of philosophy in the Royal University of Turin, speaks of agencies of which we shall never know anything and of others with which we shall inductively become acquainted, although we shall always ignore many of their respective quantities, qualities and differences. He says that the electric fluid explains the sympathy known to exist between amber and straws, which latter is shown by the analogy observed between electricity and magnetism to be the same as that existing between iron and the loadstone.

A. D. 1754.——Mr. Strype produces the sixth and last edition of the original "Survey of London," by John Stow, which first appeared during the year 1598.

In his account of Cornehill Ward, allusion is made to the "fair new steeple" of the Church of Saint Michael th' Archangel, "begun to be built in the year 1421," and, at page 74, occurs the following: "As I have oft heard my father report, upon St. James' night, certain men in the loft next under the bells, ringing of a peal, a tempest of lightning and thunder did arise, an ugly shapen sight appeared to them, coming in at the South window and lighted on the North, for fear whereof they all fell down and lay as dead for the time, letting the bells ring and cease of their own accord; when the ringers came to themselves, they found certain stones of the North window to be razed and scratched, as if they had been so much butter, printed with a lion's claw; the same stones were fastened there again and so remain to this day."

In one of the notes to William T. Thoms' reprint of above named "now perfectly invaluable" work, he says: It is quite clear from the tone in which Stow speaks of this "ugly shapen sight" and the marks "printed with a lion's claw," that he suspected this instance of the power of the electric fluid to be nothing less than a visitation from the foul fiend himself. Franklin, though no exorcist, has proved himself a great layer of such spirits.

Speaking of Saint Paul's Cathedral, Stow tells us that its pulpit cross "was by tempest of lightning and thunder defaced," and that "on Wednesday, the fourth of June (in the year 1561), between four and five of the clock, in the after-noone, the steeple of Paule's in London, being fired by lightning brast forth (as it seemed to the beholders) two or three yards beneath the foote of the crosse, and from thence burnt downe the speere to the stone worke and bels, so terribly, that within the space of foure houres, the same steeple with the roofes of the church . . . were consumed."

Stow is perhaps best known by his "Annales, or a Generalle Chronicle of England." In that portion of the latter work devoted to "The life and raigne of Queene Elizabeth" he states (London Ed., 1631, page 809) "that the knowledge and use of the sea compasse or needle was neither familiar nor understood but few yeeres before" the time of the navigators John Hawkins, Francis Drake, Martin Frobisher and Thomas Candish, and he adds (at page 810) that "the honour of that invention, as touching the propertie of the Magneticall needle in pointing towards the Poles is attributed, by Blondus in his *Italia Illustrata* (in the description of Campadia Felix) and by Paulus Iovus, in Lib. 25 of his History in the end (*sic*), to the citizens of Amalfi. . . . The author's name is no more particularly recorded, then (*sic*) to be one Flavio . . . for to him that honour is given by Francis Lopez, of Gomara, in his West Indian History, Lib. 1, Cap. 9, and by Peter Ciezius, in Lib. 2, Cap. 9, of his Indian Story, and by Pandulph: Collenutius in his History of Naples, who, three hundred yeeres since, namely in the yeere of our Saviour 1305, discovered that propertie in the Magnes and applied it to navigation." (See, for Flavius Blondus: George Hakewill, "An apologie, etc.," Oxford, 1635, lib. III., sec. IV., and lib. V., page 60; "Blondi Flavii Fortiriensis . . . Italia Illustrata," 1531, folio; Flavius Blondus (Flavio Biondo), "Roma Ristaviata et Italia Illustrata," Vinezia, 1558, 12mo; Niceron, "Mémoires . . . des hommes illustres," Paris, 1731, vol. XVI., pp. 274–281. A contemporary of Flavius Blondus, by name Michael Angelus Blondus, author of "De Ventis et Navigatione," published at Venice in 1546, likewise alludes to the polarity of the needle, and gives a curious illustration of a mariner's compass at page 15, chapter XXIV. of the last named work.)

Stow, likewise, alludes (page 810) to Dr. Gilbert's *De Magnete*, to the "diuision of the plot or playne of the compasse into the thirty-two points," considered by "Goropius, in his Lib. 3 *De Origin. Hispanicis*, to have been the inuention of some Germane," and to the manner and "meanes saylers vsed to sayle, before they atteined the knowledge of the compasse."

The Montreal Convention.

The Windsor Hotel has been selected as the headquarters of the National Electric Light Association during the coming convention, to be held at Montreal, beginning on the 7th of September next, and the meetings will be held in the spacious Windsor Hall in the hotel.

The rates of charges for board have been obtained from the two larger hotels, and are as follows: Windsor—$3.50 to $5.00 per day; St. Lawrence Hall—$2.50 to $4.00 per day. The price varies in accordance with the character and location of room. Letters addressed to either of these houses, "Montreal, Canada," will receive prompt attention.

Special rates of railroad fare have been obtained from the various traffic associations on the certificate plan, and those attending will pay full fare going to Montreal and one-third fare returning, provided they return by the same route by which they went. Arrangements will no doubt be made for special trains for the accommodation of delegates and friends from Chicago, New York City, Boston, and other principal cities. For further particulars regarding local transportation inquiries may be addressed to any one of the following-named gentlemen: Geo. F. Porter, Girard Building, Philadelphia, Pa.; R. D. McGonnigle, Allegheny

* Continued from THE ELECTRICAL WORLD, Aug. 15, 1891.

County Light Company, Pittsburgh, Pa.; W. A. Kreidler, *Western Electrician*, 6 Lakeside Building, Chicago; E. R. Weeks, Edison Electric Light and Power Company, Kansas City, Mo.; Jas. I. Ayer, Municipal Electric Light and Power Company, St. Louis, Mo.; A. C. Shaw, 620 Atlantic avenue, Boston, Mass.

Special rates of freight have been granted by the Canadian railroads, by which exhibitors are obliged to pay

FIG. 6.—CORE CONNECTIONS.

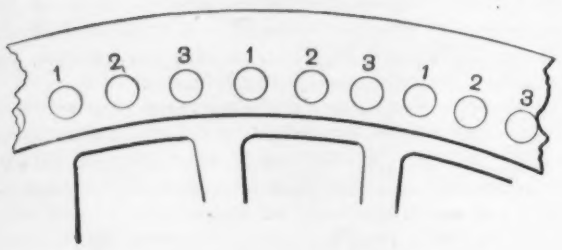


FIG. 5.—ARMATURE CONNECTIONS.

freight only one way, provided the goods remain the property of the original owner.

As at present arranged, the sessions of the convention will be held from 10 o'clock in the morning until 2 o'clock in the afternoon, final adjournment for the day being had at the latter hour.

On the 8th of September the reports of the following committees will be read and discussed:

(1) Committee on Relations of Manufacturing and Central Station Companies.

(2) Committee on Data.

(3) Committee on World's Columbian Fair.

(4) Committee on Legislation.

(5) Committee on Underground Conduits and Conductors.

(6) Committee on Safe Wiring.

On the 9th of September the following papers will be read and discussed:

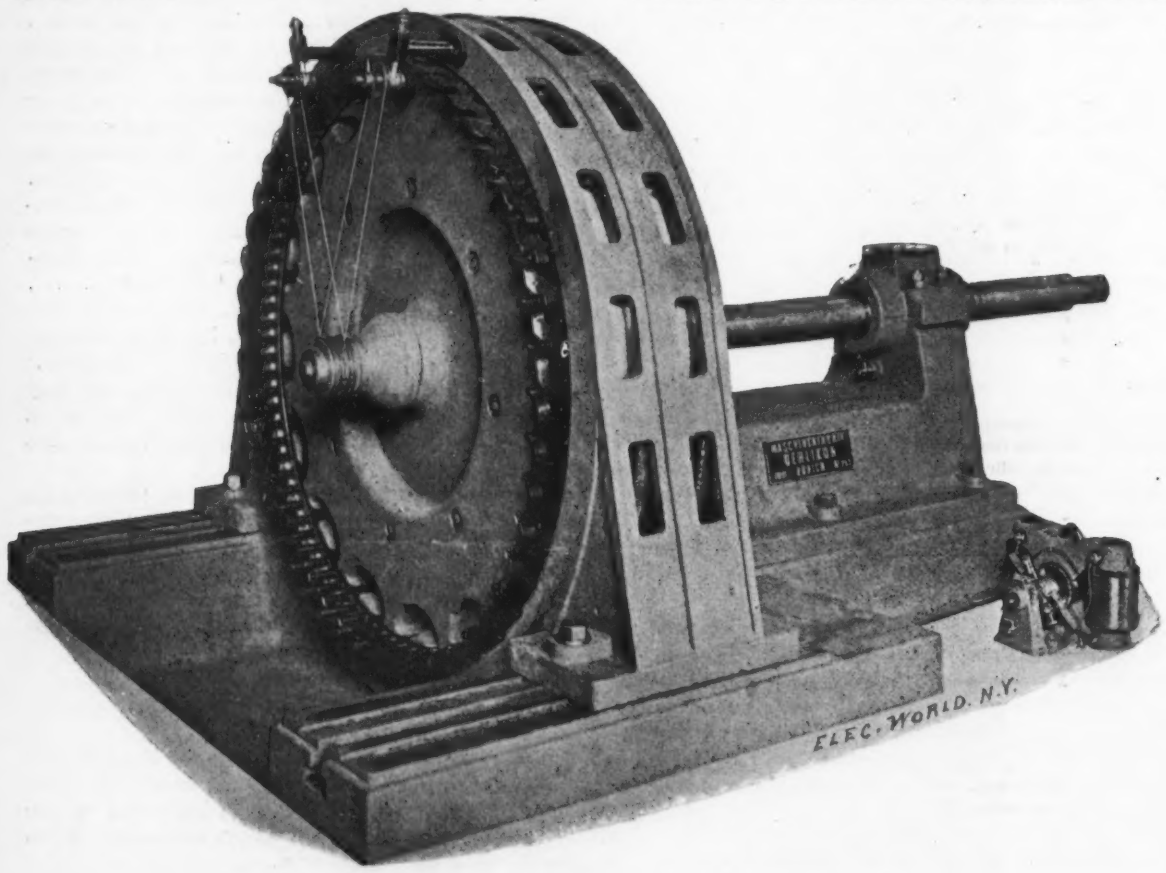


FIG. 1.—DYNAMO FOR LONG DISTANCE POWER TRANSMISSION.

Discussion of T. Carpenter Smith's paper read at the Providence convention on the "Distribution and Care of Alternating Currents."

W. C. Warner, "Various Forms of Carbons for Use in Arc Lamps."

Capt. Eugene Griffin, "Three Years' Developments of Electric Railways."

H. Ward Leonard, "A Central Station Combining the Advantages of both Continuous and Alternating Current Systems."

On the 10th of September the reading and discussion of the following papers will take place:

Jas. I. Ayer, "Some Details of the Care and Management of an Arc Lighting Station, as Practiced in the Municipality of St. Louis."

C. J. Field, subject to be announced.

George A. Redman, "Central Station Lighting by Water Power."

J. J. Burleigh, "Uniformity of Method in Keeping Central Station Accounts."

An executive session will be held on the 10th of September to elect three new members of the Executive Committee and to name the place of the next meeting.

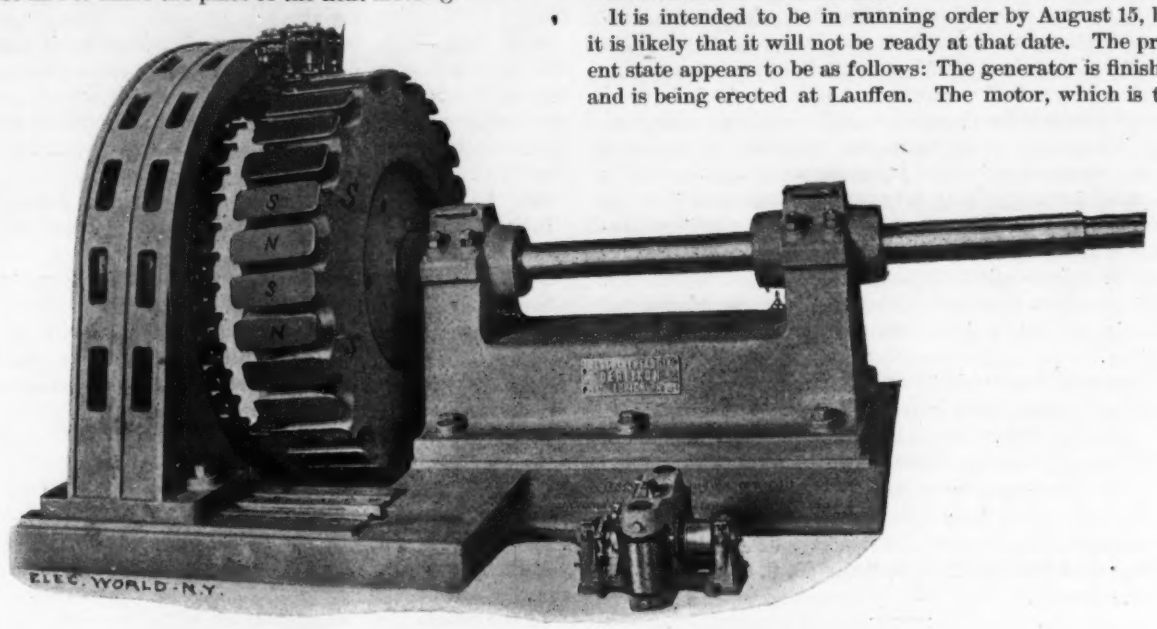


FIG. 2.—DYNAMO FOR LONG DISTANCE POWER TRANSMISSION.

Some further particulars of the convention and its arrangements are given in our Canadian notes in another column.

Electrical Practice in Europe as Seen by an American.—III.

THE ALTERNATING CURRENT POWER TRANSMISSION AT FRANKFORT.

Through the kindness of Mr. Huber, one of the directors, the writer had the pleasure of visiting the Oerlikon Works, near Zurich, Switzerland, and to see the present state of the dynamo, motor and transformers for the great alternating current transmission of power to be exhibited at the Frankfort Exhibition. It will be remembered that this exhibit, the progress of which the whole electrical fraternity is watching with much interest, is to be a transmission of almost 100 h. p. a distance of 180 kilometres, or about 112 miles, by means of alternating currents, from the small town of Lauffen (not far from Heidelberg) to the electrical exhibition at Frankfort-on-the-Main, Germany. The Oerliken Works are constructing the dynamo, the motor and two of the transformers, all designed by their electrical engineer, Mr. C. E. L. Brown, who is already well known to electricians by his creditable work in the construction of dynamos. The Allgemeine Elektricitäts Gesellschaft, of Berlin, will construct the other two transformers, designed by their electrical engineer, Mr. Dolivo von Dobrowolsky. The system to be employed is that invented by the latter engineer, and known here as the "drehstrom" ("revolving current"), or "three phrase alternating current," consisting briefly of three alternating currents of equal strength generated by a single dynamo, the wave in each of which is one-third of a wave length behind the other, or in technical language, having a difference of phase of 120 degrees. Such a current is particularly well suited for driving alternating current motors, and as it is an alternating current it can be transformed up and down by specially constructed transformers, and is therefore well suited for long distance transmission. It requires three line wires instead of two as usual.

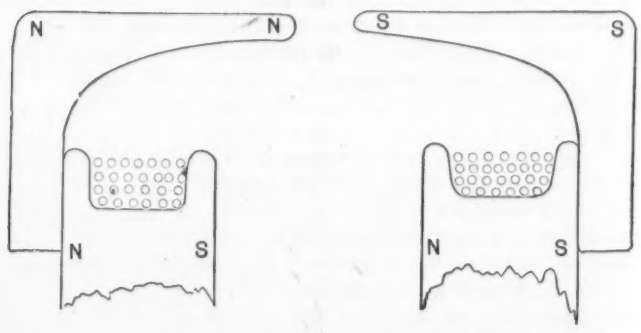
It is intended to be in running order by August 15, but it is likely that it will not be ready at that date. The present state appears to be as follows: The generator is finished and is being erected at Lauffen. The motor, which is the exact duplicate of the dynamo in every respect, is still at these works, but appears to be nearly finished. The two Oerlikon transformers are in course of construction. One of them appears to be nearly finished. The line is stated to be only partly finished. As the dynamo and motor have not yet been run together, nor with the transformers, it is not unlikely that there will be some further delays even after all the machinery is in place. It would be quite surprising if all went smoothly from the start, in such a novel and large undertaking, which the whole electrical world is watching.

Through the kindness of one of the directors of the Oerlikon Works, the writer was furnished with the following description of the dynamo (the motor being the exact duplicate), which is best given here in the original, and is stated to be the first description given to the public.

The more general extension of the transmission of energy by means of electricity has caused great researches to be made with a view of bringing into use some of the many natural sources of water power, by increasing the efficiency and so transmit the power over greater distances.

Continuous current is not suitable for the high tension that is so necessary for long distance transmission. Alternating current has the great advantage that it can be transformed, but up to the present there have been difficulties in using alternating current for motors, which is by far the widest field of application for the utilization of sources of natural water powers.

The three-phase alternating current system is a great step in advance, as it permits of transformation and the driving of motors up to any power. The Oerlikon Works have for some years given much attention to the electric transmission of power, and have now in hand several important transmissions on the new three-phase alternating current system with generators and motors constructed by their electrical engineer, Mr. C. E. L. Brown, and showing a remarkable degree of efficiency.



FIGS. 3 AND 4.—A SINGLE COIL AND POLE PIECE.

By referring to the annexed drawing it will be seen that the dynamos are for current of low tension, the high tension being used only in the line. "Step up" transformers are used at the generators and "step down" transformers at the motors. The figure (Fig. 1) shows a dynamo capable of absorbing 300 h. p. at 150 revolutions per minute. The armature is wound so as to give three separate alternating currents with 120 degrees difference of phase, at a tension of 50 volts and a strength of 1,400 ampères. To avoid taking off this heavy current with brushes or sliding contacts, the armature is stationary and the field magnet revolves. The conducting copper wires or bars, are 29 mm. (about 1¼ inches) diameter; they pass through holes in the sheet-

iron core, bored close to the internal periphery of the armature. These upper bars are insulated from the iron core by tubes of asbestos. This arrangement has proved to be free from Foucault currents even with solid copper conductors up to 50 mm. (2 inches) diameter, sections which under ordinary circumstances could not be used without considerable heating.

The passing of copper conductors through holes in the core gives the impression of solidity and security, with other mechanical advantages, such as absence of risk of abrasion from contact with the moving parts or displacement from accidental short circuit. The air space is also reduced to a minimum, and consequently a great saving of exciting current is effected in comparison with ordinary dynamos of the same size. This arrangement of passing wires through holes in the periphery of the sheet iron cores has been extensively used by the Oerlikon works since 1885, and they find its application to the three phase dynamos gives results more than usually satisfactory.

The magnetic field has 32 poles, and for each of the three phases of current there are 32 conducting bars connected in series on the armature, making $3 \times 32 = 96$ bars. The connection of the three circuits with each other is the same as in the Thomson-Houston arc dynamo.

The armature core is carried in a cast iron frame which is fixed to the main bed plate in such a manner that it can be moved lengthwise for the removal of the magnetic field. The field is excited by only one coil wound on a cast iron drum, on each side of which is bolted a cast iron disc or pole piece, each with 16 projections on the outer edge projecting across the coil toward the opposite pole piece. As these projections from one side pass alternately between the projections from the pole piece on the other side of the coil, they form a magnetic field of 32 poles, all the projections on the one steel disc being positive and all on the other disc being negative. This arrangement of the magnetic field is most advantageous, resulting in a great economy of current for exciting and also of copper, with great simplicity of connections, as it will be seen that the whole magnetic field of 32 poles is composed of only four parts, which can be simply and solidly fixed on the shaft, a very important point in the construction of dynamos for large powers.

The exciting current is led to the revolving magnetic field by means of wire cords running over two grooved discs on the end of the shaft to pulleys supported on the frame of the machine, which pulleys are connected to the terminals, thus avoiding brushes or other sliding contacts with the revolving magnetic field. The shaft carrying the magnets is supported by two heavy bearings firmly bolted to the foundation plate, the end supporting the magnets being free, for connections by coupling, belt or gear, to the turbine or other source of power, or to carry a driving pulley when used as a motor.

It will be seen that this dynamo can be used as a generator or as a motor, like an ordinary alternate current dynamo. When used as a motor it must be run synchronously with the generator, but with the great advantage that it can be started from a state of rest, and the exciting current switched on when it is running synchronously with the generator. When the generator and motor are started together, the exciting current can be switched on to both from the moment of starting, as the torque of the motor rises with the speed in a perfectly satisfactory manner.

The following interesting data will prove that this type of dynamo has very strong claims from an economical point of view over the ordinary types of dynamos:

1. Total weight of copper field magnet coil 300 kilos., or about one-quarter of the usual weight for a 300 h. p. dynamo.

2. The exciting current for the magnet field at normal speed and an open circuit, at a potential of 50 volts, is equal to about 100 watts, or one-twentieth of the energy that is required for an ordinary dynamo of 300 h. p.

3. With the addition necessary to counterbalance the armature reaction when under full load, the total exciting current is less than one per cent. of the output of the machine. At the speed trials of the machine the losses from friction at the bearings, air spaces, hysteresis, etc., amounted to 3,600 watts, or 1.6 per cent. to 1.7 per cent. of the output. Adding to this the loss in the copper bars of the armature (say 3,500 watts) and the energy required for the field at full load, leaves a commercial efficiency of 96 per cent., a result which has not been surpassed by any dynamo of this size running at the same speed. On account of these small losses in hysteresis and Foucault currents, there is little or no heating, and the machines can easily meet any sudden demand or strain that may, and often does, occur in transmitting power for industrial purposes.

4. The total weight of the machine without the foundation plates is 9,000 kilogrammes.

From the above it will be seen that most remarkable and satisfactory results have been obtained by the intelligent utilization of the many valuable characteristics of this type of dynamo.

The following is a list of the important installations that are being furnished or are in course of construction at the present time by the Oerlikon Works:

One machine for the transmission of power from Lauffen to the Frankfort Electrical Exhibition, a distance of 180 kilometres.

One machine for the central station for power distribution of Heilbronn; distance, 10 kilometres.

One machine for an installation of distribution of power from Dieblikon to Zurich; distance, 10 kilometres.

Five machines as follows: Three generators with vertical shafts for coupling direct to vertical turbines; two motors with horizontal shafts for driving the entire plant of the Oerlikon Works; distance, 23 kilometres.

The above are equal to a total of about 1,800 h. p.

To this description may be added the following remarks and sketches: Fig. 2 shows the other side of the dynamo with the armature moved to one side, so as to show the revolving field with its multiple pole pieces. The wire of the single large field coil is not visible; it lies directly below the field pieces, perpendicular to them, that is, parallel to the circumference. Figs. 3 and 4 show each a single pole piece on the common coil. The whole field magnet may be said to be a single, very short magnet of very great diameter, the two poles of which have numerous pole pieces which extend over the outside of the coil, passing each other, but not meeting, thus forming a nearly closed magnetic circuit. It is equivalent in effect to a large number of radial magnets, but is evidently much simpler in construction.

The connections of the armature may be better understood from the sketch, Fig. 5, which shows a portion of the armature with twelve wires and three poles of the field magnet. All the wires marked 1 are connected in series all the way around the armature and form one of the three circuits. All those numbered 2 are similarly connected and form the second circuit. Similarly, those numbered 3 form the third circuit. One end of each of these circuits leads to its line wire, while the other ends are simply all three connected together. When a transformer is used, as in the present case, this common junction of the three wires is connected to a similar junction of the other ends of the three wires at the transformer, making a fourth wire leading from the dynamo to the transformer.

The transformers consist of three vertical cylinder cores of iron, laminated longitudinally and surrounded each by a circular primary and a secondary coil, half of the primary (a secondary) being between the secondary and the core, and half being ouside of the secondary, as in the Ferranti transformers. The three cores are magnetically connected at their like ends by a common iron ring laminated perpendicularly to the radius. Fig. 6 is a diagrammatic representation of the disposition of the three magnetic cores and their end connections. The whole transformer is contained in a cast iron case containing rosin oil, such as is used in the Brooks underground system.

There will be two transformers at each station. Each will be capable of transforming to about 12,000 volts, thus enabling them to be used in series for about 2,500 volts or in multiple arc for about 12,000.

CARL HERING.

ZURICH, Aug. 1, 1891.

New York Meeting of the Association of Edison Illuminating Companies.

The seventh annual convention of the Association of Edison Illuminating Companies met according to the call issued by the Executive Committee, at the Murray Hill Hotel, in this city, on Tuesday morning, Aug. 11, with a very full attendance. The list of members following will be seen to comprise representatives from a large number of Edison illuminating companies operating in various parts of the country, in addition to the representatives sent by the Edison General Electric Company:

Edison General Electric Company, New York City: J. Hobart Herrick, vice-president; E. H. Johnson, director; L. Stieringer; Wilson S. Howell, inspector, lamp manufacturing department; Francis E. Jackson, inspector lamp manufacturing department; H. Ward Leonard, general manager, light, power and intelligence departments; W. J. Jenks, legal department; E. W. Hammer, legal department; W. H. Lauman, legal department; Chas. D. Shain, district manager, Eastern district; A. H. Reece, manager, Southern district; M. J. Sullivan, official stenographer; A. E. Kennelly, Edison laboratory; G. D. W. Williamson, engineering department; A. E. Winchester, engineering department; J. H. Vail, assistant engineer-in-chief, engineering department; W. S. Andrews, technical assistant, engineering department; Samuel Insull, second vice-president; J. P. Ord, comptroller; S. Dana Greene, assistant to second vice-president; Morris Slattery, agent Southern district; F. R. Upton, general manager lamp manufacturing department; Sidney B. Paine, district manager New England district; W. S. Kelly, engineering department; W. T. Edgar, engineering department; N. T. M. Mottram, assistant to district manager, Southern district; S. A. Douglas, New England district.

Edison Electric Illuminating Company, of Philadelphia: Wm. D. Marks, supervising engineer and general manager.

Edison Electric Illuminating Company, Paterson, N. J.: Wm. M. Brock, manager and secretary.

Edison Electric Illuminating Company, Pottsville, Pa.: Geo. H. Barker, manager.

Toronto Incandescent Electric Light Company, Toronto, Canada: J. K. Kerr, director and attorney.

Reading Electric Light and Power Company, Reading, Pa.: T. P. Morritt, J. K. Righter, general manager.

Edison Electric Light Company, York, Pa.: G. P. Yost, president; C. A. Eisenhart, vice-president; H. S. Wrest, director; W. F. Wollin, superintendent.

Edison Electric Illuminating Company of New York City: R. R. Bowker, First vice-president; J. B. Skehan, treasurer; H. J. Smith, general operating superintendent; J. Van Vleck, Arthur Williams; Henry Stevenson, superintendent underground construction; F. M. Tottingham, superintendent Second district; Frank H. Briggs, acting superintendent Third district; J. E. Sayles, general agent.

Edison Electric Illuminating Company, of Brooklyn, N. Y.: C. E. Chinnock, director; W. D. Barstow, general superintendent.

Edison Electric Illuminating Company, of Boston, Mass.: Walter C. Baylies, vice-president; C. L. Edgar, general manager; W. A. Hill, cashier; Charles E. Pattison.

Harrisburg Electric Light Company, Harrisburg, Pa.: John I. Beggs, director; W. R. Fitzpatrick, superintendent and electrician.

Edison Electric Illuminating Company, of Detroit, Mich.: C. P. Gilbert, secretary and manager; Hoyt Post, attorney; Barton L. Peck, motor inspector.

Grand Rapids Edison Light and Fuel Gas Company, Grand Rapids, Mich.: A. F. Walker, superintendent; S. C. Harnish, constructor.

Appleton Edison Light Company, Appleton, Wis.: A. L. Smith, president.

Consolidated Electric Light Company, Birmingham, Ala.: Leigh Carroll, secretary and general manager.

Des Moines Edison Light Company, Des Moines, Ia.: J. A. Colby, director, secretary and manager.

Columbus Edison Electric Light Company, Columbus, O.: A. W. Field, secretary and manager.

Edison Electric Light and Power Company, St. Paul, Minn.: Geo. H. Finn, secretary and treasurer.

Edison Electric Illuminating Company, Lawrence, Mass.: W. H. Wolvekamp, electrician.

Edison Electric Illuminating Company, Topeka, Kan.: W. W. King, superintendent.

Edison Electric Illuminating Company, Westchester, Penn.: Maurice Hoopes, superintendent.

Edison Electric Light and Power Company, Kansas City, Mo.: W. Preston Hix, director.

Tiffin Edison Electric Illuminating Company, Tiffin, Ohio: A. Kaup, manager.

Edison Electric Light and Power Company, Little Rock, Ark.: G. H. Van Etton, president.

Elgin City Railway Company, Elgin, Ill.: Chr. Wustenfeld, manager.

Scranton Illuminating Heat and Power Company, Scranton, Pa.: J. E. Parrish, superintendent.

Wilmington City Electric Company, Wilmington, Del.: C. Reginald Van Trump, general superintendent and manager.

Toronto Incandescent Electric Light Company, Toronto, Canada: Frederic Nicholls, manager and secretary.

Renovo Electric Light, Heat and Power Company, Renovo, Pa.: J. H. Sheddy, general manager.

Forest City Electric Light and Power Company, Rockford, Ill.: M. A. Beal, secretary, treasurer and manager.

Mt. Holly Electric Light and Power Company, Mt. Holly, N. J.: J. L. Jamison, superintendent and treasurer.

Edison Electric Illuminating Company, Rochester, N. Y.: H. L. Brewster, secretary.

Edison Electric Illuminating Company, Amsterdam, N. Y.: J. H. McClement, vice-president; H. K. McCoy, general manager; T. D. Mosscrop, secretary and treasurer.

Winston-Salem Railway and Electric Company, Salem, N. C.: J. H. McClement, president; H. S. Cooper, general manager.

Edison Electric Illuminating Company, Hazleton, Pa.: J. Edwin Giles, manager.

Edison Electric Illuminating Company, New Orleans, La.: Wm. Oswald, director.

Grand Rapids Edison Lighting and Fuel Gas Company, Grand Rapids, Mich.: John R. Markle, director.

Edison Electric Illuminating Company, Brooklyn: R. Lindsay.

Edison Electric Illuminating Company, New York: W. I. Donshea, assistant electrician; J. H. Tyler, superintendent motor department; H. A. Campbell, assistant superintendent.

At the morning session, after the credentials of delegates were passed upon, an address was made by the president of the association, after which Mr. A. E. Kennelly, Mr. Edison's assistant at the laboratory, read the report of the committee on "The Grounding of the Neutral Wire in Three Wire Systems," and the report of the committee on "Lightning Protection." The report of Mr. C. P. Gilbert, of Detroit, Mich., chairman of the committee, was read by Mr. H. Ward Leonard, manager of the light and power department of the Edison General Electric Company, on "Dangers to Edison Circuits from Crosses with High Potential Conductors." These reports were followed by a free discussion on all of the topics presented. The convention extended the privileges of a portion of its session to Mr. A. S. Hibbard, general superintendent of the American Telephone and Telegraph Company, and Mr. John J. Carty, electrician of the Metropolitan Telephone and Telegraph Company, during the discussion of the reports on protection from lightning and high potential circuits.

On reconvening, at 2:30 P. M., the delegates were invited by the officials of the Edison Illuminating Company, of New York, to visit its various stations now in operation and the new Elm street station now in process of construction. An invitation was also given to accept the further hospitality of this company at a dinner to be given at the Brighton Beach Hotel, returning to New York City in the evening.

The second day's session of the annual convention of the association was called to order promptly at 10 A. M. by the president, Mr. John I. Beggs. The session was opened with the discussion of Mr. A. E. Kennelly's report on the "Grounding of the Neutral Wire in Three Wire Systems," read at the first session. This was followed by the reading of a paper by Prof. Wm. D. Marks, supervising engineer and general manager of the Edison Electric Light Company, of Philadelphia, on "How to Get Paying Loads for Stations." A paper was read by Mr. R. S. White on "The Edison Motor in the Brooklyn Station." Mr. Samuel Insull, second vice-president of the Edison General Electric Company, made an address on the present business policy of the parent company, the outlook in the patent suits, the present condition of the business, etc.

At the close of the session, invitations for the excursion to Schenectady on Thursday as arranged by Mr. Insull were distributed to the members. A paper by Mr. Leigh Carroll, of Birmingham, Ala., on "Some Practical Ideas on Distribution," was presented by its author. Mr. A. E. Kennelly, of the Edison laboratory, presented a paper on "A Mechanical Meter" and exhibited a model. Mr. Wilson S. Howell read a paper on the "Peculiar Features of the Edison Feeder System," and Mr. W. J. Jenks presented a paper on the "Success of the Mutual Insurance Idea in Electric Light and Power Stations."

The choice of officers for 1891-2 resulted in the re-election of the old staff, as follows: President, John I. Beggs; vice-president, C. L. Edgar; secretary, W. J. Jenks; treasurer, W. S. Howell. The executive committee is

made up of the following named gentlemen: A. L. Smith, C. P. Gilbert, Thos. P. Merritt, H. J. Smith, Leigh Carroll and John I. Beggs.

After the election the report of the executive committee and that of the treasurer were read. An invitation was then extended to the delegates by the Edison Electric Illuminating Company, of Brooklyn, to visit its station at the end of the afternoon session. A paper was read by Mr. Luther Stieringer on "Incandescent Lamps for Decorative Purposes." The choice of a meeting place for 1892 resulted in the selection of Toronto, Can., at the invitation of Mr. Frederic Nicholls of the Edison Electric Illuminating Company of that place.

The special train which was to convey the party to Schenectady left the Grand Central station at 6 A. M. with all the party on board, excepting, perhaps, one or two stragglers who failed to rise at that early hour. Breakfast was served in the dining car attached to the train, and upon reaching Schenectady the entire train was sidetracked in the yards of the Edison company. After inspecting the shops for several hours, the party returned to the dining car and partook of the lunch which was prepared for them. The afternoon was spent in further examination of the different branches of the Edison company's immense factory, and late in the afternoon the party again boarded the train and returned to New York City, dinner being served, as was the breakfast, in the dining car. In response to the invitation of the New York Edison Illuminating Company, a large number of delegates to the convention attended the Gilmore concert at the Madison Square Garden, inspected the immense isolated plant in that building, and also the electrical arrangements connected with the stage of the Garden Theatre. The opinion freely expressed by a large number of the delegates was to the effect that the New York meeting had been the most successful and enjoyable ever held by the association, and a number of compliments were paid to the officers of the Edison General Electric Company and the New York Edison Illuminating Company for the royal manner in which they had treated the Edison people from the various stations throughout the country.

Electrolysis by Means of the Alternating Current.*

BY DR. GUGLIELMO MENGARINA.

RECTIFICATION OF ALTERNATING CURRENTS BY MEANS OF ELECTROLYSIS.

It may be easily shown that a voltameter with gold or platinum electrodes becomes polarized by the passage of an alternating current. If the electrodes have different areas the larger one behaves like the electrode surrounded by hydrogen in a gas battery. The polarization or secondary current is of few moments. But if the voltameter receives a rapid series of charges with an alternating current, the discharges are all in the same direction, and consequently a true rectification of an alternating current is effected.

In order to show this I made use of a rotating contact-breaker (Fig. 5). Two wooden cylinders, *A* and *D*, were mounted on the same spindle, and each was provided with a brass tube, *A B C D*, cut off helically at the extremities. The spindle, *O O'*, was rapidly rotated by means of a series of spur wheels and pinions. Six copper wire brushes, capable of sliding on a wooden rod, rubbed on the surfaces of the cylinders. During a rotation the brushes 1, 2, 5 and 6 were in contact with the metal surfaces for a greater or smaller period of time, according to their position on the wooden rod; the brushes 3 and 4 were in permanent contact with the metal surfaces. Three distinct circuits were connected to these three pairs of brushes. An acidulated water voltameter was connected to 3 and 4, a reflecting galvanometer with its shunt to 2 and 5, and leads to the poles of an alternating current transformer to 1 and 6. With this arrangement, on rotating the spindle *O O'*, at first an alternating current of short duration was sent through the voltameter, and then the current due to the polarization set up was sent through the galvanometer, and the needle was deflected, but returned immediately to zero. If, however, the rotation was made sufficiently rapid it was found possible to find a speed at which the needle was permanently deflected.

Several different pairs of metals were examined, but the best results obtained were from the combination gold-platinum. The gold electrode had a surface of 300 square millimetres, and the platinum electrode 900 square millimetres. On rotating the commutator at a velocity of 5 to 10 revolutions per second, and placing the first and second pairs of brushes so that the voltameter was connected to the galvanometer for three-quarters of a revolution, and for less than one-quarter to the transformer, a direct current was obtained varying from 14.10 milliampères to 47.00 milliampères. The charging current could be varied from 0.5 to 3 ampères without obtaining any better result.

CONCLUSIONS.

(1) In a voltameter traversed by an alternating current polarization is set up, varying periodically both in intensity and sign, in consequence of which the phase of the current is displaced behind that of the potential difference of the voltameter poles.

(2) Electrolytic decomposition by means of an alternating current cannot take place unless the maximum value which can be reached by the polarization during an alternation is equal to, or greater than, a certain definite limiting value depending on the natures of the electrolyte and the electrodes and the current density at each electrode.

In this case, during each alternation from the moment when the polarization reaches this limit, electrolytic decomposition will occur, and will continue until the end of the alternation; that is, until the curve representing the current passes through the value zero. Thus, during each alternation, there are two distinct periods; in the first, which lasts from the commencement of the current phase until the polarization reaches the limiting value, decomposition will not take place; in the second, which occupies the remaining portion of the alternation, electrolysis proceeds regularly, and the quantity of the electrolyte decomposed will be proportional to the quantity of electricity which has passed through the voltameter in this interval. During successive alternations the same phenomena are repeated, so that at the end of any time it will be found that during a fraction only thereof has electrolysis been able to take place.

(3) If we have two currents, one direct and the other alternating according to a sine curve, such that each conveys the same quantity of electricity through a voltameter in a given time, the quantity of the electrolyte decomposed by the former will be to that decomposed by the latter as the area corresponding to the duration of an alternation reckoned between two consecutive passages of the current through the zero value is to the area comprised in the interval of time during which electrolysis has been able to take place.

(4) Diminishing the current density on one of the electrodes at which the products of electrolytic decomposition appear has the effect of diminishing the polarization at this electrode. Consequently a point can be reached at which the polarization during an alternation cannot reach the limiting value at which the products of decomposition can

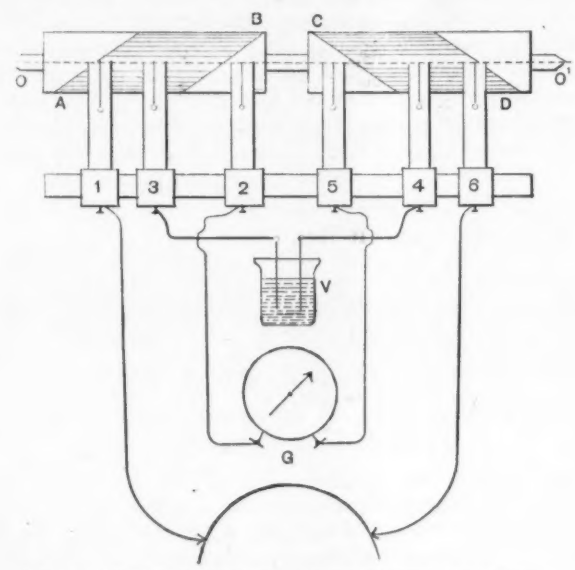


Fig. 5.—Electrolysis by Alternating Currents.

commence to appear; electrolysis will then cease to take place at this electrode.

If no electrolytic decomposition is seen to take place at one electrode of a voltameter traversed by an alternating current, increasing the current density will increase the polarization so that it is possible to reach the above mentioned limit, and then electrolysis will become visible in this electrode.

(5) On increasing the rapidity of alternation of an alternating current, the strength and current density remaining constant, the polarization on the same electrode in the same voltameter will continually decrease, so as to render it possible to bring it below the limit necessary for the products of electrolysis to be able to appear.

On the other hand, if, with a certain number of alternations, electrolysis is not obtained, diminishing the number of alternations will increase the polarization so as to make it possible to reach the limit necessary for the products of decomposition to appear.

(6) The energy consumed in a voltameter traversed by an alternating current is less than the product of the square root of the mean square of the current and the square root of the mean square of the potential difference at the voltmeter poles. A voltameter traversed by an alternating current behaves like a metallic conductor possessing self-induction.

(7) The ratio between the real and the apparent energy consumed in a voltameter traversed by an alternating current is nearer and nearer to one, the greater is the quantity of the electrolyte decomposed, the current density and number of alternations remaining constant.

If the same quantity of the electrolyte is decomposed by an alternating current as by a continuous current of equal quantity, the difference between the energies really and apparently consumed in a voltameter must be zero. The phases of the curves representing current and difference of potential at the voltameter poles would then be synchronous.

(8) In a voltameter containing acidulated water, or a saline solution, the quantity of the electrolyte decomposed at an electrode by an alternating current (the current density at the electrode and the number of alternations remaining constant) increases if an obvious re-combination of the gases at the other electrode takes place. Owing to this re-combination, a direct current is superimposed on the alternating current, modifying its character.

In this way, with alternating currents, metallic deposits of copper, silver, nickel, etc., quite equal to those produced by direct currents can be obtained.

(9) Alternating currents can effect the decomposition of fused salts, and this decomposition is subject to the current density law.

(10) After a voltameter with gold or platinum electrodes has been traversed by an alternating current, a polarization that will last some little time will be produced.

In general the electrode with the greater surface will act as the hydrogen electrode in a gas battery. The smaller electrode often presents a more intense polarization, but of shorter duration.

(11) By taking advantage of this polarization, voltameters through which alternating currents pass can be used as a means of rectifying the same, transforming them into a series of direct currents of short duration, succeeding each other at brief intervals.

(12) During electrolysis by alternating currents the electrodes are vigorously attacked and quickly destroyed.

Even platinum, gold and iridium become covered with a powder, which increases, until it finally completely destroys the electrode.

Notes on Permanent Magnets.—III.*

BY PROF. SILVANUS P. THOMPSON, F. R. S.

Methods of Magnetizing.—The ancient methods of magnetizing, including "single-touch," "double-touch," "divided-touch," "circular-touch," in all their varieties, may be dismissed as obsolete. The only methods needing attention are those based upon the use of electric currents. Arago discovered this way in 1820, and magnetized steel needles by inserting them within a spiral coil connected to a voltaic battery. Elias, of Haarlem, in 1844, proposed a useful variation of this process. Instead of winding the wire in a long tubular spiral, he coiled it in a compact ring of many layers, which could be slipped loosely over the piece of steel which was to be magnetized, and then moved along it from end to end, so as to bring every part successively into an intense magnetic field. In 1846, Böttger suggested a modification for special application to horseshoe magnets, consisting of two coils oppositely wound, to be slipped over the two polar ends simultaneously.

Sinsteden used, for magnetizing horseshoe forms, a powerful two-pole electromagnet, against the polar ends of which the steel horseshoe was placed, and while thus *in situ* stroked the horseshoe in the direction from bend to poles with an armature of iron resting across the two limbs. Van der Willigen, in his remarkable treatise † on the Haarlem magnets forged by Van Wetteren, described the method used for those famous magnets. The steel horseshoe is placed with its poles against the pole pieces of a Ruhmkorff electromagnet, and the current from 10 or 20 Bunsen cells is then turned on and off three or four times. The current being cut off, the horseshoe is then raised into a vertical position, and the keeper is slid across its poles before these are removed from contact with the electromagnet. The magnet is then in a supersaturated state, holding on to its keeper with a pull about 30 per cent. greater than the permanent pull which it will exhibit. For larger magnets Van der Willigen made a simultaneous use of the Ruhmkorff electromagnet as described, and of an Elias ring, which he slid to and fro from one end to the other of the horseshoe, from 20 to 100 times, while the electromagnet was also in action.

For small bar magnets and compass needles it suffices to draw them over the poles of a large electromagnet, each extremity of the piece of steel being finally touched against the pole of opposite kind, and pulled off normally. For straight bars of considerable size, Van der Willigen used the same electromagnet, adjusting the distances between the polar faces to correspond to the bar to be magnetized, and then applied the same process as for horseshoes, but, of course, without applying a keeper.

One process, known as Hoffer's method, consists in stroking the steel horseshoe from the poles to the bend with an iron rod laid across the limbs, while it is in contact with the poles of another previously magnetized horseshoe. Van der Willigen, who examined this method, found it faulty and even harmful. It set up inequalities in the distribution of the magnetism, and diminished the effective power of magnets previously magnetized as described above.

Another process, which has been suggested at various times as an improvement on the ordinary processes, is to subject the magnet to powerful magnetizing forces during the act of hardening. Robinson placed the steel bars red hot against the poles of a strong magnet, and in this position applied cold water to the bar. Holtz says that thick steel bars so magnetized during sudden cooling are twice as powerful as those magnetized in the cold; and that thin bars are three times as powerful. Aimé and Hamann have also advocated this method; which, however, does not seem to have any real advantages.

Moser, in 1838, made a comparative trial of various

*Continued from The Electrical World, August 15, 1891.

*From *The Electrician* (London). Continued from The Electrical World, Aug. 8, 1891.

† Van der Willigen, *Sur le Magnetisme Aimants artificiels.* (Archives de Musée Teyler, Haarlem, vol. IV., 1878.)

methods, as applied to a parallelopipedal steel rod weighing 12 ounces. He measured the degree of magnetization by the method of oscillation, observing the time required for one complete swing. From the duration of the oscillation the relative strengths are calculated. The results of eight methods, each better than the preceding, are given as follows.

	Time of 1 swing, (sec.)	Relative strength.
1. Knight's method of "divided stroke," using two permanent magnets; 20 strokes on one side of rod only	22.13	1
2. Same, repeated on all four sides	14.87	2.21
3. Same, repeated with masses of iron laid under each end of the bar	14.63	2.29
4. Same, repeated while bar placed on top of a reversed steel magnet	12.13	3.33
5. Mitchell's method of "double stroke," using two separate steel bar magnets	11.13	3.95
6. Same, using a steel horseshoe	10.19	4.71
7. Æpinus' method of "circular stroke," using same horseshoe magnet	8.75	6.39
8. With an electromagnet: rod laid on two iron pole pieces on the poles of the electromagnet, and while here stroked with steel horseshoe; the current of the electromagnet then turned off, and rod then lifted off	8.0	7.62

These experiments leave no doubt as to the superiority of the modern method over the ancient ones.

Constancy of Magnets.—It by no means follows that the magnet which shows the greatest amount of permanent magnetism will be the most constant in its retention of the same. Magnets lose their magnetism from many causes, such as accidental shocks, contacts with other magnets or pieces of iron, changes of temperature, slow annealing of the steel and the like. The relation of these influences to the quality and temper of the steel, and to the dimensions of the magnet, are not very well known, but some information exists.

Gray,* using glass-hard magnets, found the percentage of loss of magnetism due to a small demagnetizing force (that of unit field) to vary widely for magnets of different lengths. A bar 10 diameters long lost 0.8 per cent.; one 20 diameters long lost 0.6 per cent.; 40 diameters long, 0.5 per cent.; while one 100 diameters long lost about 0.44 per cent.

Bosanquet,† using a considerable number of magnets made (on Feb. 8, 1885) from the best cast steel, as hard as they could be made, found the following fall in magnetic moments:

Feb. 18	12,539	April 8	11,620
March 3	11,822	Sept. 18	11,119
March 15	11,767		

Lamont‡ made an investigation, lasting eleven years, as to the constancy of the magnets used in the Observatory at Munich for the daily magnetic measurements. These magnets had already been repeatedly alternately immersed in warm and cold water, but had not attained by this process a state of constancy, as the following figures show. The losses are given in decimal parts of the whole magnetic moment:

Months.	1848.	1849.	Months.	1848.	1849.
January	0.0000	0.0000	July	0.0028	0.0016
February	0.0003	0.0001	August	0.0032	0.0022
March	0.0003	0.0002	September	0.0028	0.0022
April	0.0008	0.0005	October	0.0017	0.0013
May	0.0014	0 0007	November	0.0009	0.0007
June	0.0022	0.0011	December	0.0005	0 0001

The total decrease in various years, also in terms of the whole magnetic moment as unity, was as follows:

1847	0.0174	1853	0.0099
1848	0.0169	1854	0.0103
1849	0.0103	1855	0.0081
1850	0.0091	1856	0.0099
1851	0.0113	1857	0.0071
1852	0.0079	1858	0.0063

According to Barus,§ mean atmospheric temperature, acting on freshly quenched steel for a period of *years*, produces a diminution of hardness (with consequent loss of permanent magnetism) about equal to that which would be caused by the action of a temperature of 100 degrees C. acting for a similar period of *hours*.

Some persons have sought to explain the slow decay of magnetism by reference to chemical changes of the surface due to oxidation, moisture, etc., and have proposed to prevent such decay by gilding, silvering or lacquering the surface of the magnet. Such remedies are entirely ineffectual, and the supposition on which they are based is erroneous.

Cheesman observed the percentage loss of magnetism caused by percussion, the magnets being allowed to fall from a height, with the following results:

Brand and temper.	Height of fall in metres.	Percentage loss of magnetism.
Steel wire, soft	1.5	30
" " mechanically hardened	2.0	44
" " "	3.0	57
Steel rod, mechanically hardened	2.0	52
" " "	7 times, do.	81
Iron wire, mechanically hardened	2.0	84
" " "	3 times, do.	95
" " soft	2.0	83
" " "	3.0	99
Iron rod, soft	2.0	97
Steel wire, glass-hard	3.0	6
" " "	3.0	4

W. Brown,‖ using magnets made from silver steel, all 10 centimetres long, endeavored to find a relation between the temper of the magnets and the percentage loss of magnetism due to percussion after the magnets had been laid aside for various periods of time. His results are embodied in the following table, from which it will be seen that the glass-hard temper appears to be the most constant in this respect. It is less certainly shown that long magnets are more constant than short ones:

Temper.	Diam'ter ratio. δ.	Specific magnetization. σ.	Loss per cent. due to percussion after lying aside for				
			1 hr.	20 hrs	44 hrs	1 mth	3m'ts
Glass-hard	33	41	1.98	2.0	1.95	1.04	0.8
" "	50	45	2.96	3.2	1.48	1 00	0.0
Yellow	33	44	6.03	6.1	4.8	5.4	6.2
"	50	46	4 0	3.5	3.76	2.6	4.0
Blue	33	54	11.8	10.8	9.71	11.8	7.5
"	50	71	8.2	8.2	8.18	7.5	8.7

Strouhal and Barus, who have made so many researches upon the physical properties of steel, have examined the question of magnetic constancy in relation to form, temper, and exposure to fluctuations of temperature. They found that a glass-hard magnet, 119 diameters long, lost 30 per cent. of its magnetism when heated for six hours in steam 100 degrees C., but the same magnet, when re-magnetized, and again heated in steam, now only lost 5.3 per cent. The loss of magnetism on the first heating was found to vary in magnets of different lengths.

A magnet of 119 diameters' length lost 30 per cent.
" 108 " " " 28 "
" 35 " " " 49 "
" 14 " " " 67 "

In every case after protracted heating in steam, a condition was attained in which neither the specific magnetization nor the specific resistance (*i. e.*, the hardness as measured electrically) showed an appreciable further change. These investigators came to the conclusion that magnets so treated possess a special fixidity, and resist not only changes of temperature but mechanical shock, better than magnets prepared in any other way. As an example, they took a short magnet 2.5 centimetres long, 0.4 centimetre wide, and 0.3 centimetre thick. This was boiled in water for four hours, then magnetized and kept two hours longer in steam. Its magnetic moment was then observed, after which it was laid on a wooden log, and violently beaten 50 times, both lengthways and sideways, with another mass of wood. It then showed a diminution of only $\frac{1}{900}$; and after a repetition of the beating only showed a loss of about $\frac{1}{400}$. In another experiment a tubular steel magnet was made glass-hard, magnetized, then heated for 30 hours in steam, re-magnetized and heated for 10 hours more in steam. This magnet when allowed to fall 10 times, on its ends, from a height of 1.5 metres, showed a permanent diminution of only $\frac{1}{4750}$ of its magnetism. It is accordingly recommended that all magnets for use in magnetic observations should be prepared as follows: Make the magnets glass-hard, then place in steam at 100 degrees for 20 or 30 hours, or longer for very massive magnets. Then magnetize as fully as possible and then heat again for five (or more) hours in steam. Such magnets will then be as constant as they can be made.

In quite another way Mr. G. Hookham* has sought to obtain magnets of constant power, for use in his electrical meters. A number of bar magnets of tungsten steel are fitted into cast iron pole pieces which nearly meet, so constituting a nearly closed circuit. After these are fitted on, a magnetizing current is sent round the bar magnets to saturate them as fully as can be done. They are then mechanically hammered, and a weak demagnetizing current is sent through the coils, reducing the magnetism by about 10 per cent. Then for many months the magnets will show no tendency whatever to lose; indeed they may slightly gain.

Profits from Exhaust Steam at Electrical Stations.

BY "B."

One of the modern marvels is the rapidity with which electricity has been applied to the lighting of cities and villages, to the propulsion of street cars and to the performance of other work. And this wonderful development is going on from month to month with increased momentum. No matter if the profits of operating come short of anticipations formed, the progress of the business will not be materially delayed. And yet the projectors of these plants are in duty bound to protect the men who furnish the money, without which the wheels of progress would not move.

Upon economy of management and the utilizing of all the forces at command depends the measure of success which each individual enterprise will accomplish. No legitimate source of revenue is intended to be neglected. Plans are carefully made, and the details of construction worked out to the best advantage. Engines are constructed with a view to an economical transmission of power, a boiler plant is selected which will show the highest duty from carefully selected coals and labor employed with a view to reducing the cost of operation. All these things are regarded as essential in any well constructed and properly managed plant.

In nearly all cases steam power is employed to develop the electric current. This necessitates larg batteries of boilers at central points, to the extent of hundreds and often of thousands of horse power. In performing engine work it is well known that only a small part of the steam generated is condensed, while the remainder escaping as exhaust steam is lost.

This steam, if conveyed to buildings, can be utilized and sold for heating purposes, its commercial value for heating being reckoned at $2,500 to $5,000 per 100 h. p. during the heating season. The plan of heating from central stations is an established industry already in more than forty cities and villages. It is, therefore, no longer experimental. Should the electric companies ignore this source of revenue? Some of them have already adopted the plan of selling their exhaust through pipes laid underground, deriving a large net revenue therefrom. In some instances the investment for steam mains has returned the first season an excess of 25 per cent. upon first cost. The only additional investment required by an electrical company in order to utilize this exhaust is for the underground mains. Office and boiler-house expenses would not be increased. No more fuel is required. The same steam that generates the power produces the heat for houses, offices, stores or public buildings. Ready customers are always at hand. The steam system has in all cases proved popular with the consumer. He is saved the labor and annoyance of keeping fires. He has no coal to store. The dust and gas from stoves and furnaces are avoided. The risk of fire on the premises is minimized and lower rates of insurance can be obtained. In fact, among all the modern improvements, none of them, not even electric lighting, brings an equal amount of comfort and satisfaction to the family or the office of the man of business.

In many branches of manufacture the sale of the by-product constitutes in amount the margin of profit. It must be utilized from necessity. Eliminate this from the account and the business would be done at a loss. At the steam station, after the steam has passed the engine it becomes a by-product. Shall it be dissipated into the atmosphere, or shall it be utilized for useful work and turned into money? The building of so many large boiler plants for electrical work makes this a subject of much importance at the present time to managers and investors.

Armature Reactions.*

BY FRANK C. WAGNER, A. M., B. S.

Notwithstanding the fact that open-coil armatures were among the first to be used in the commercial dynamo-electric machine, the electromagnetic reactions occurring in them have always been somewhat of a mystery, and have generally been deemed incapable of exact analysis. It is not to be wondered at, in consequence, that the open-coil dynamo stands practically where it did 10 years ago, while the closed-coil type has undergone successive modifications until it is now one of the most efficient machines known for the transformation of energy. It is not expected in what follows to clear away all difficulties, but it is hoped to present a method of attacking the problem which will throw light upon what is actually going on within an open-coil armature, and open up the way to an exact quantitative analysis of the effect of armature reactions.

All of what follows is based upon two fundamental laws of electromagnetism, which are now universally acknowledged to be valid. They are: (1) That the electromotive force set up in one turn of a conducting wire is equal to the *rate of change* of magnetic induction within that turn. (2) That the magnetic induction in a closed magnetic circuit is equal to its magnetomotive force divided by its magnetic resistance. The term magnetic induction corresponds to what is frequently called lines of force, and magnetomotive force corresponds to magnetizing force.

By the use of the second law above stated it is possible to calculate the magnetic induction through the armature of a dynamo-electric machine when the form and dimensions of the machine are given, together with the magnetic quality of the iron and the magnetizing force of the field magnets. The formula used for this purpose is:

$$H = \frac{4\pi nC}{10}\left(\frac{1}{\frac{lo}{Ao} + \frac{l_1}{\mu^1 A^1} + \frac{l_2}{\mu_2 A_2} + \text{etc.}}\right),$$

in which H is the value of the magnetic induction in C. G. S. units: n is the number of turns of wire in both field magnets; C is the current in ampères flowing in each turn of wire; lo and Ao are respectively the length of the cross-section in centimetres of the air space included in the magnetic circuit; l_1, A_1 and μ_2 are the length, cross-section and permeability of any homogeneous piece of iron included in the circuit; l_2, A_2 and μ_2, etc., apply to other pieces of iron in the circuit.

Knowing the induction through the armature coils, the number of turns of wire on the armature, and the number of revolutions per minute, it would seem an easy matter to calculate the induced electromotive force. And so it would be, were it not for the armature reactions. It is evident that as soon as a current flows through the armature an induction will be set up within the armature which will react upon the induction produced by the field magnets, changing both its value and its direction. The problem is to find this resultant induction.

Magnetic induction is a quantity of the nature of a vec-

* *Phil. Mag.*, vol. XX., p. 484, 1885.
† *Ib.*, vol. XIX., p. 57, 1885.
‡ Lamont's "Handbuch des Magnetismus" (1867), p. 410.
§ *Phil. Mag.*, Nov., 1888, p. 403.
‖ *Phil. Mag.*, vol. XXIII., p. 293, 1887.

* *Journal* Institution Electrical Engineers, vol. XVIII., p. 688, 1889.

* From *The Technic*.

tor, *i. e.*, it has magnitude, direction and sense. Hence it will be completely represented by a straight line of definite length with an arrow head to indicate its sense. Two inductions acting in different directions may be combined to form a resultant induction, and in general the laws of the composition and resolution of forces apply to any number of magnetic inductions acting at the same point. It is to be noted, however, that in the case where the medium in which the inductions are superimposed is iron, the addition of inductions may saturate the iron and thus change the magnetic resistance of the various circuits, and consequently alter the values of their inductions. It would seem, then, that if we could determine the magnitude and direction of the induction of each coil of the armature we might combine these with the induction of the fields and find the direction and magnitude of their resultant. This is what I propose to do in what follows.

Let Fig. 1 represent a section through the pole pieces of a Thomson-Houston arc dynamo, the armature core being shown in outline. Let the lines 2, 1, 3, represent the position of the three coils of the armature and the direction of motion be that indicated by the arrow. From actual trial the lead on the machine under consideration is known to be about 40 degrees. Then the dotted line $N'S'$, making an angle of 40 degrees with the centre line of the field magnets NS, gives the direction of the resultant field approximately. In the figure, No. 2 coil is taken parallel to the resultant induction. We will consider the induction as directed from south to north outside of the magnetizing coil and from north to south within it. The current flowing in coil No. 2 will create a south pole at s and a north pole at n. Hence if A, Fig. 2, represents the induction due to field magnets, $O\,B$ drawn parallel to $n\,s$ will represent the induction due to coil No. 2. The sense of $O\,B$ is from n to s, because the field is within the magnetizing coil. In a similar way $O\,C$, perpendicular to No. 1 coil, and $O\,D$, perpendicular to No. 3 coil, represent the inductions due to coils 1 and 3.

The lengths of $O\,A$, $O\,B$, $O\,C$ and $O\,D$ are determined as follows: In the formula for H, given above, n is 3,990; C is 6.8; $lo = 8.88$; $Ao = 1{,}772$; $A^1 = 98.24$ for the armature core. If the iron of the armature core be not saturated, evidently the term within the parenthesis having the greatest value will be $\frac{lo}{Ao}$, which equals .0049. Neglecting the other terms, the value of H becomes 6,960,000, giving an intensity of magnetization $\frac{A}{H} = \frac{6960000}{98.24} = 70{,}800$. According to Ewing and Low (*Phil. Trans.*, vol. 180, p. 221), the saturation point of best wrought iron is 21,360. Hence it is readily seen that the armature core must be saturated. The induction carried by the iron will be $98.24 \times 21{,}360 = 2{,}098{,}000$ C. G. S. units. The magnetomotive force is found to be 34,095. Then the magnetic resistance of the circuit corresponding to the induction in the iron of the armature core is $34{,}095 \div 2{,}098{,}000 = .0162$. Of this amount .005577 is outside of the armature core. Hence the equivalent resistance of the armature core is $.0162 - .005577 = .01062$.

But the space occupied by the iron can carry, in addition, an induction equal to what would be carried if the iron were replaced by air, so that we have another path for the induction through the spherical air space inside the armature winding. To find approximately the magnetic resistance of this air space divide it into five concentric hollow cylinders. Finding the mean length and cross-section of each

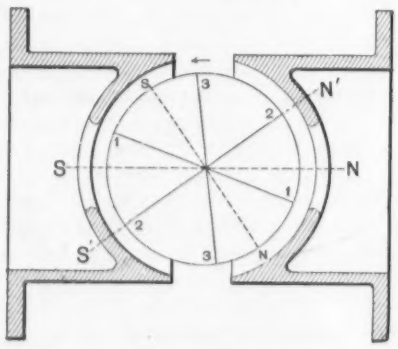


Fig. 1.—Armature Reactions.

cylinder, compute its magnetic resistance. The equivalent resistance of these combined circuits is then found in exactly the same manner as is the equivalent resistance of electrical circuits connected in parallel. In this case it is found to be .0172. Combining with the equivalent resistance of the armature core we get $\frac{1}{\frac{1}{.0106} + \frac{1}{.0172}} = .00656$. Including the air gap we get as the entire resistance from pole to pole within the armature winding $.00656 + .0049 = .01146$. In like manner the magnetic resistance of the space occupied by the armature winding and of the space entirely outside of the armature are found to be approximately .159 and .297. The entire equivalent resistance from pole to pole will then be

$$\frac{1}{\frac{1}{.01146} + \frac{1}{.159} + \frac{1}{.297}} = .00785$$

The magnetic resistance of the remainder of the circuit is determined by considering the length and cross-section of each iron portion of the circuit together with its permeability at the actual intensity of magnetization, and substituting in the formula $\frac{1}{\mu A}$. It is found to be .000978, giving for the total magnetic resistance .008828. The total magnetic induction is $.34095 \div .008828 = 3{,}862{,}000 = H_1$. Of this amount only a part, represented by $\frac{.00785}{.01146} \times H_1 = 2{,}645{,}000$, passes entirely within the armature winding. Another portion, equal to $\frac{.00785}{.159} \times H_1 = 190{,}700$, passes through the space occupied by the armature wire; and of this, one-half, or 95,350, is inclosed by the mean turn of wire on the armature. The effective induction through the mean turn of armature wire is then $2{,}645{,}000 + 95{,}350 = 2{,}740{,}350$. The remainder of the induction, 1,121,650, constitutes the stray field, and is practically lost so far as the generation of current is concerned. Assuming some convenient scale, make the line $O\,A$, Fig. 2, equal to 2,740,350 on that scale.

It is evident that in an armature of only three coils the electromotive forces induced at different points in the revolution must be quite different. In consequence the

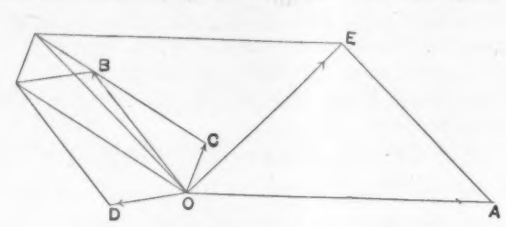


Fig. 2.—Armature Reactions.

current flowing in the armature coils will vary. Again, two of the armature coils are always connected in parallel with the third in series, so that, since the magnetic induction varies with the current, it is first necessary to determine the current values in each coil. This is done as follows:

Assuming the induction to be uniformly distributed and parallel to the resultant induction, we have, if H is the total induction passing through the mean coil when perpendicular to the resultant induction, and ϑ is the angle which the coil makes with the resultant induction, $H \sin$ is equal to the induction through the coil in any position. The induced electromotive force is equal to the rate of change of induction. Hence the electromotive force generated in a turn of wire making an angle ϑ with the resultant induction is $\frac{d}{dt}(H \sin \vartheta) = H \cos \vartheta \frac{d\vartheta}{dt}$. Since the angular velocity $\frac{d\vartheta}{dt}$ is uniform, the electromotive force generated in one coil is readily calculated by the well-known formula $E = \frac{4NnH}{10^8}$, where N is the number of revolutions per second, n is the number of turns of wire in the armature coil, and H is the total magnetic induction passing through the coil when perpendicular to the resultant induction. If E_1 is the maximum value of the electromotive force, then in general $E = E_1 \cos \vartheta$ and $\int_0^{\frac{\pi}{2}} E d\vartheta = E_1 \int_0^{\frac{\pi}{2}} \cos \vartheta d\vartheta = E_1 \sin \vartheta \Big)_0^{\frac{\pi}{2}} = E_1$. Hence the mean value $E' = E_1 \div \frac{\pi}{2}$; whence $E_1 = \frac{\pi}{2} \times \frac{4NuH}{10^8}$. In this case E_1 is taken as 3,454 volts.

Now studying the position of the brushes upon the commutator, we find that for full load with coils in the position shown in Fig. 1, No. 2 coil is in series with Nos. 1 and 3 in parallel. Hence for No. 2 coil $\vartheta = 0$, and $E = 3{,}454$ volts. For Nos. 1 and 3 $\vartheta = 60°$, and $E = 1{,}727$ for each. The total electromotive force then equals 5,181 volts.

Suppose the armature to move forward 10 degrees. The connections will be the same as before, No. 2 coil in series with 1 and 3 in parallel. For No. 2 coil $\vartheta = 10°$ and $E = 3{,}401$. For No. 1 coil $\vartheta = 50°$ and $E = 2{,}220$. For No. 3 coil $\vartheta = 70°$ and $E = 1{,}181$. The total electromotive force for this position will then be $3{,}401 + \frac{1}{2}(2{,}220 + 1{,}181) = 5{,}101$ volts. In a similar manner we find the total electromotive forces for positions at equal intervals apart through a complete cycle of values, in this case through 60°. Taking the mean of these values we get 4,909. The mean current is known to be 6.8 ampères. Now for any position the current value will be to the mean current as the total electromotive force in that position is to the mean total electromotive force. Hence the value of the total current is known for any given position. This gives the current in the coil which is connected in series in that position. But the distribution of current in the coils which are connected in parallel remains to be determined.

Referring to the case in which No. 2 coil makes an angle of 10 degrees with the resultant induction, it is seen that the electromotive forces generated in 1 and 3 are 2,220 and 1,181 respectively. Evidently there will be a tendency for a local current to circulate in coils 1 and 3, due to the difference of these electromotive forces. Such a current will flow and will be of such magnitude that the change of induction which it produces in coils 1 and 3 will generate a counter electromotive force in them to balance the difference of electromotive forces existing. Since coils 1 and 3 are practically equal, one-half of this counter electromotive force will be induced in each. The sense of the counter electromotive force induced in No. 1 coil will be such as to reduce the original electromotive force, and in No. 3 coil such as to increase the original electromotive force. So that the resultant electromotive force will be $\frac{1}{2}(2{,}220 + 1{,}181)$ as taken above. To find the value of this local current we proceed as follows:

Let $\triangle C$ be the change occurring in the value of this local current during a small fraction of a revolution, *e. g.*, 5 degrees. Let E_d be the mean difference of electromotive forces in coils 1 and 3 during this fraction of a revolution. Let Q be the resistance of the magnetic circuit through one of the coils in the position under consideration. Let n' be the number of turns of wire in one armature coil. Let T be the time, in seconds, which it takes for the armature to make the assumed fraction of a revolution. Applying the formula for H we get for the change in induction due to the changes in current $\triangle C$, $H_d = \frac{4\pi n' \triangle C}{10} \times \frac{1}{Q}$, where Q replaces the polynominal $\frac{l_0}{A_0} + \frac{l_1}{\mu_1 A_1} + \text{etc.}$ Now by our first general law the induced electromotive force in one turn is equal to the rate of change of the induction, $= \frac{H_d}{T} = \frac{4\pi n' \triangle C}{10QT}$. Hence in n' turns the induced electromotive force is $\frac{4\pi n'^2 \triangle C}{10QT} = E \times 10^8$; or E (in volts) $= \frac{4\pi n'^2 \triangle C}{10^9 Q T} \therefore \triangle C = \frac{E \times 10^9 \times QT}{4\pi n'^2}$.

Applying this formula to a movement of No. 1 coil from $\vartheta = 60°$ to $\vartheta = 55°$ and of No. 3 coil from $\vartheta = 60°$ to $\vartheta = 65°$, we have the following: Electromotive force of No. 1 coil when $\vartheta = 55°$ equals 1,982 volts. Electromotive force of No. 3 coil when $\vartheta = 65°$ equals 1,460. Difference equals 522 volts. When for both coils $\vartheta = 60°$ the difference is zero. Hence the mean difference is 261. Of this one-half, or 130.5 volts, must be induced in each coil by the reaction of the local current. From known data of the dynamo we have $Q = .01$; $T = .00098$; $n' = 1{,}333$.

$$\therefore \triangle C = \frac{130.5 \times 10^9 \times .01 \times .00098}{4\pi \times 1333 \times 1333} = .058 \text{ ampère.}$$

In a similar manner the changes in the local reaction current can be found for successive portions of a revolution included within a cycle of changes. It will be noticed that no account has been taken of the drop in electromotive force due to the dead resistance in the reaction circuit. In this case the combined resistance of the two coils is 24 ohms hot, giving a back electromotive force due to dead resistance of $24 \times .058 = 1.4$ volts, which may be neglected in comparison with 261 volts.

The next point is to determine in what position the total current divides equally between the two coils connected in parallel. The only assumption which gives cyclic changes is that the current divides equally just before and just after commutation, *i. e.*, when for two of the coils $\vartheta = 30°$, and for the third $\vartheta = 90°$. In this position we find for the value of the total current 6.21 ampères. Suppose No. 1 coil to have been commutated immediately preceding; then No. 2 coil will be in series, with 1 and 3 in parallel. The current in No. 2 coil will be 6.21 ampères, and in Nos. 1 and 3 3.105 ampères each. Let the armature turn through 10 degrees. In

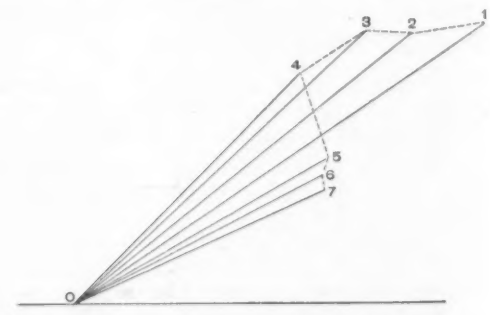


Fig. 3.—Armature Reactions.

this new position the total current is found to be 6.74 ampères. $\triangle C = 1.107$ ampères. Hence the current flowing in No. 4 coil will be $\frac{6.74}{2} + 1.107 = 4.477$; and No. 1 coil will be $\frac{6.73}{2} - 1.107 = 2.263$. In this manner the current flowing in each coil at any position of the armature can be determined.

The resistance of the magnetic circuit of each armature coil can be determined in the same manner as in the case of the main magnetic circuit, being careful to observe which portions of the armature core are saturated. Knowing the current, the number of turns and the magnetic resistance, we have all the data necessary to determine the induction. For example, in the position shown in Figs. 1 and 2 the total current is found to be 7.1[illegible] ampères, and flows in No. 2 coil. The magnetic resistance for No. 2 coil is determined to be .00876. Hence the induction $= \frac{4\pi \times 1333\ 7.18}{10 \times .00876} = 1{,}371{,}000$. In Fig. 2 make $OB = 1{,}371{,}000$ on the scale chosen. In a similar manner make $OC = 464{,}000$ and $OD = 685{,}000$. Combining these vectors we

get *OE* for the resultant induction, both in direction and magnitude.

In like manner finding the resultant inductions for a number of positions within a cycle, *i. e.*, from one point of commutation to the next, and drawing the vectors all on one diagram, we get Fig. 3; 01, 02, 03, etc., represent both in direction and magnitude the resultant inductions for positions 10 degrees apart; 07 is the induction immediately before commutation, and 01 immediately after. The armature is short-circuited for an interval corresponding to three degrees at full load. What takes place during commutation it is not possible to state.

Calculating what would be the total induced electromotive forces if the inductions are as shown in Fig. 3 we get the following, where the numbers correspond with resultant inductions in Fig. 3:

(1)	4,486	(5)	3,041
(2)	4,233	(6)	2,777
(3)	4,067	(7)	2,513
(4)	3,382		

Taking the mean we get 3,500 volts. This type and size of dynamo in actual work carries from 55 to 58 arc lights.

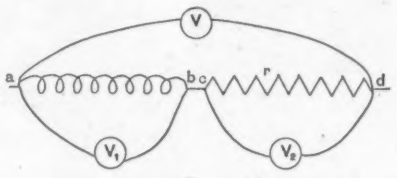


FIG. 1.—ALTERNATING CURRENT ANALOGIES.

Allowing 52 volts to a lamp this corresponds to an external electromotive force of from 2,860 to 3,016 volts. The drop of potential in the dynamo due to dead resistance is about 500 volts, giving a total of from 3,360 to 3,516 volts. There is also a counter electromotive force of self-induction in the field magnets of indeterminate amount varying with the quality of iron employed. The agreement of the calculated with the actual electromotive force is fully as good as could be expected.

Alternate Current and Potential Difference Analogies in the Methods of Measuring Power.*

BY PROF. W. E. AYRTON, F. R. S., AND W. E. SUMPNER, D. SC.

I.

In a paper read by us before this society on March 6 it was pointed out that for every problem involving alternate P. Ds. *in series* there was an analogous problem involving alternate *currents in parallel*. This general proposition tells us that we can transform each of the P. D. equations given, for example, in our paper on "The Measurement of the Power Given by any Electric Current to any Circuit," read before the Royal Society April 9, 1891, into a current equation, and so transform our method of calculating power by the measurement of three P. Ds. into a method of calculating power by the measurement of three currents.

Such a transformation of our equations has been recently carried out by Dr. Fleming, in the *Electrician* for May 8, and the method he arrives at, as well as the three-voltmeter method of which it is an analogue, are seen in Figs. 2 and 1. If V_1, V_2, V_3 be the readings of the voltmeters in Fig. 1, and A_1, A_2, A_3 the readings of the three ammeters in Fig. 2, and r the resistance of the non-inductive portion of the circuit $c\ d$ in each case, then the mean watts

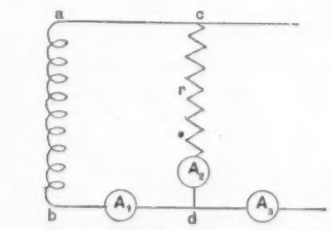


FIG. 2.—ALTERNATING CURRENT ANALOGIES.

given to $a\ b$ are respectively, whatever be the nature of the circuit $a\ b$ or of the current,

$$\frac{1}{2r}(V_3^2 - V_1^2 - V_2^2)$$

and

$$\frac{r}{2}(A_3^2 - A_1^2 - A_2^2).$$

The three-ammeter method has the advantage over the three-voltmeter method in that the dynamo need not give a larger P. D. than that necessary to send the current through $a\ b$; it is inferior to the three-voltmeter method in that, while it is possible to measure V_1, V_2 and V_3 rapidly in succession by using only one voltmeter, it is of course impossible to use only one ammeter to measure A_1, A_2 and A_3 without constantly interrupting the circuit, and hence it would be necessary to accurately calibrate three instruments if this current method were employed.

But the main objection to this current method is that, as Dr. Fleming points out, it does not possess the accuracy of our three-voltmeter method of measuring power. For in order that this three-current method may give accurate results it is necessary to assume, to quote from our Royal Society paper, "the entire absence of self and mutual induction from a circuit some portion of which is necessarily of a solenoidal form."

It is possible, however, to obtain a current analogue of

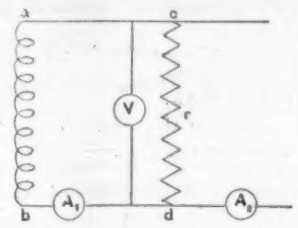


FIG. 3.—ALTERNATING CURRENT ANALOGIES.

our three-voltmeter method which shall have the accuracy of the three-voltmeter method itself. And as the general proposition given in our previous paper tells us that the current analogues of P. D. arrangements *in series* are current arrangements *in parallel*, it follows that with this other method also the dynamo will not be required to produce a greater P. D. than that necessary to send the current through the circuit, the power given to which we desire to measure.

The method is as follows: In parallel with the circuit $a\ b$ (Fig. 3), the power given to which we wish to measure, connect a non-inductive resistance of r ohms (in circuit with which no instrument is placed, which would necessarily make the so-called non-inductive branch more or less in-

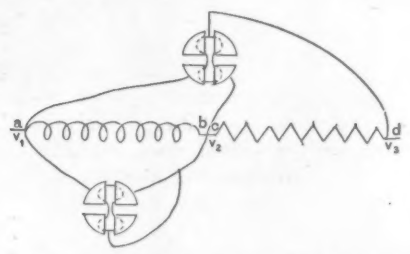


FIG. 4.—ALTERNATING CURRENT ANALOGIES.

ductive). Let A_3, A_1 and V be the readings of the two ammeters and the voltmeter placed as shown; then, from the equations given in our Royal Society paper, it follows at once that the mean watts given to $a\ b$ are

$$\frac{r}{2}\left\{A_3^2 - A_1^2 - \left(\frac{V}{r}\right)^2\right\}.$$

It is interesting to notice that if $a\ b$ were the primary coil of a transformer, it would be when the load on the secondary was small, that is when the current passing through $a\ b$ was small, that it would be most difficult, on account of lag, to measure with ordinary methods the power given to $a\ b$. But that is exactly the case when it is most easy to use

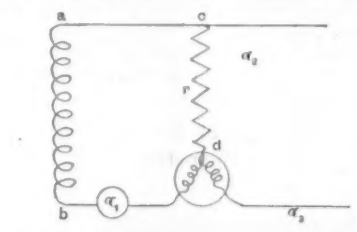


FIG. 5.—ALTERNATING CURRENT ANALOGIES.

our one-voltmeter and two-ammeter method, since when the dynamo has to send little current through $a\ b$ there is little objection to requiring it to send a current through $c\ d$ in parallel with $a\ b$.

If the voltmeter (Fig. 3) be a hot-wire instrument, then, since an appreciable current will pass through this voltmeter, r must be taken as the parallel resistance of $c\ d$ and of the voltmeter. It is important to observe, however, that there is no necessity to know either of these resistances separately, since the value of r can be determined when the three instruments A_1, A_3 and V are relatively calibrated thus: First, break the circuits of $c\ d$ and of the voltmeter, and compare the deflexion of A_3 with A_1; this calibrates ammeter A_3 relatively to ammeter A_1, the calibration of which we will assume to be correct; second, close the cir-

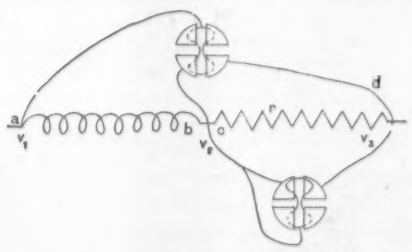


FIG. 6.—ALTERNATING CURRENT ANALOGIES.

cuits of $c\ d$ and of the voltmeter, but break the transformer circuit $a\ b$. A_3 is now in series with the parallel circuit containing $c\ d$ and the voltmeter. The value of r is therefore at once known, since r must equal the volts as read by V divided by the ampères as read by A_3.

II.

As an illustration of the general proposition to which we have referred, it may interest the members to see what are the other analogies that we have traced out between alternate P. Ds. in series and alternate currents in parallel in connection with the measurement of power.

Mr. Blakesley's method, communicated to this society in February of this year,* is the current analogue of our electrometer method of 1881. For with the electrometer method (Fig. 4) we make two measurements, one giving us the mean value of

$$(v_1 - v_2)\left(v_3 - \frac{v_1 + v_2}{2}\right),$$

the other the mean value of

$$\frac{(v_1 - v_2)^2}{2},$$

v_1, v_2, v_3 being the instantaneous values of the potentials. Then we take the difference, and so get the mean value of

$$(v_1 - v_2)(v_2 - v_3),$$

which is equal to r times the mean watts given to $a\ b$ (Fig. 4).

With Mr. Blakesley's method two measurements are made,

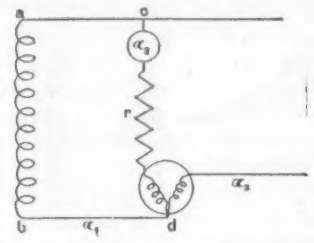


FIG. 7.—ALTERNATING CURRENT ANALOGIES.

one with a split dynamometer (Fig. 5), giving the mean value of

$$\alpha_1\ \alpha_3,$$

and the other with an ammeter, giving the mean value of

$$\alpha_1^2,$$

α_1, α_2, α_3 being the instantaneous values of the currents. Then the difference is taken, and so the mean value of

$$\alpha_1(\alpha_3 - \alpha_1) \text{ or } \alpha_1\ \alpha_2$$

is obtained, and this is equal to $\frac{1}{r}$ times the mean watts given to $a\ b$ (Fig. 5).

It is important to notice that, as no instrument is inserted in the non-inductive circuit $a\ b$ (Fig. 5), this method of Mr. Blakesley's has exactly the same accuracy as the electrometer method.

III.

The electrometer measures may, as we pointed out some years ago, be varied; and by making the connections as seen in Fig. 6 we can obtain from the two readings the mean values of

$$(v_2 - v_3)\left(v_1 - \frac{v_2 + v_3}{2}\right)$$

and

$$\frac{(v_2 - v_3)^2}{2}.$$

Then, taking the difference, we get the mean value of

$$(v_2 - v_3)(v_1 - v_2),$$

which, as before, is equal to r times the mean watts given to $a\ b$.

Mr. Blakesley has also pointed out, in his paper published in the *Phil. Mag.* for April of this year, that the current measurements may be varied and the apparatus arranged as seen in Fig. 7. The two measurements now give respectively the mean values of

$$\alpha_2\ \alpha,$$

and

$$\alpha_2^2;$$

therefore the difference gives the mean value of

$$\alpha_2(\alpha_3 - \alpha_2),$$

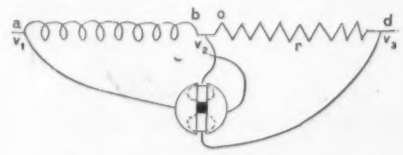


FIG. 8.—ALTERNATING CURRENT ANALOGIES.

that is, the mean value of

$$\alpha_2\ \alpha_1,$$

which is equal to $\frac{1}{r}$ times the mean watts given to $a\ b$.

While, however, our second method of using the electrometer (Fig. 6) gives the answer with the same accuracy as the first method (Fig. 4), Mr. Blakesley's second method of joining up the dynamometers in Fig. 7 introduces self-induction into a circuit which ought to be entirely non-inductive, and so it does not give the answer with the same accuracy as his first method, Fig. 5.

The modification of our electrometer method, suggested to one of us by Mr. L. Atkinson, while he was a pupil at the Finsbury Technical College, and afterward carried out by MM. Blondlot and Curie, of making an electrometer with two needles for the measurement of power, is the exact analogue of the wattmeter method. For with the double-needle electrometer (Fig. 8) we obtain from a single reading the mean value of

$$(v_1 - v_2)(v_2 - v\ ),$$

which is equal to r into the mean watts given to $a\ b$. Simi-

*Communicated by the Physical Society of London; read June 12, 1891.

Phil. Mag., April, 1891, p. 436.

larly, with the wattmeter (Fig. 9) we obtain from a single reading the mean value of

$$\alpha_1 \alpha_3,$$

which is proportional to $\frac{1}{r}$ into the mean watts given to *a b*.

While, however, the double-needle electrometer gives us the answer with perfect accuracy, the wattmeter method is liable to inacuracy from the circuit *c d* not being strictly non-inductive.

Gas Engines and Electric Light Installations.

"Having to inspect an arc and an incandescent installation at Lille, supplied with current from a dynamo driven by a gas engine, I was able," says M. Witz, in a recent note in the *Comptes Rendus*, "to compare the quantity of gas consumed in this manner with that previously consumed by the lamps and regenerative burners employed in the illumination of the same locality. Some 16 arcs and 71 16-c. p. glow lamps replaced six powerful double regenerating See lamps, 91 ordinary, and 19 batswing burners. The electric lamps gave 15 per cent. more light than the gas lamps, a fact I was able to ascertain by comparative measurements of the illumination of the floor surface, and, in addition, they lit up a few places where there had not previously been any gas lamps. Now, things being so, the gas engine only consumed 21,500 litres (752 cubic feet) per hour, while the gas lamps consumed 26,500 litres (927 cubic feet). Thus, when we employ gas as the motive power for driving a dynamo supplying current to electric lamps we consume 17 per cent. less gas than we should if we burned the gas at the burners, and we obtain much more light."

A Combined Passenger and Freight Electric Tramway.

During the latter part of April a narrow-gauge electric railway, connecting the towns of Sissach and Gelterkinden, in Switzerland, was opened to traffic. The road is intended for both passenger and freight service, and accordingly differs in several respects from the various electric roads designed simply for passenger transportation. Its gauge is one metre, and its total length a little over two miles. For two-thirds of its length the road runs along the highway between the two towns; for the remainder of the distance a special roadbed had to be laid down.

A Motor-Dynamo Plant in Brooklyn.

The accompanying illustration shows a plant made for the Edison Electric Illuminating Company, of Brooklyn, by the C. & C. Electric Motor Company. The generators supplying the feeder are operated by a motor, which, in turn, is supplied by the bus from the first district station. A 50-h. p. C. & C. motor with pulleys at both ends of the armature shaft is installed and connected to the station bus, and from this are belted two No. 6 Edison compound generators. The plant is said to show an average commercial efficiency of over 75 per cent., while the efficiency of the large station, by reason of the extra motor load, is increased over 10 per cent. The question of installing a smaller engine was contemplated, but on close investigation the idea was abandoned in favor of the motor.

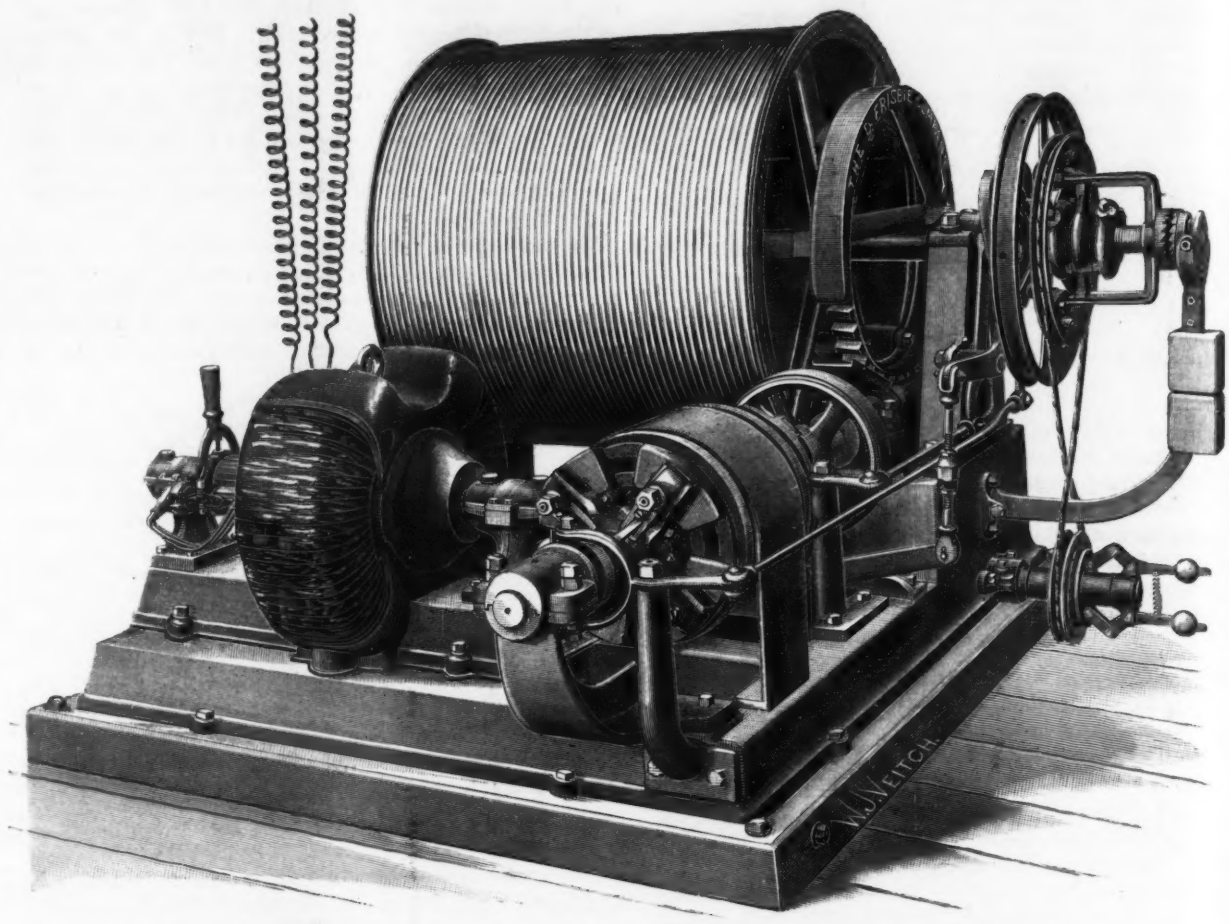
A BROOKLYN MOTOR-DYNAMO PLANT.

The total efficiency of the entire plant taken on a 24 hours run at full load is over 80 per cent. The plant is kept in operation day and night, as the dynamos are carrying a full load of 500 lights during the night, and in the day time are furnishing current to C. & C. electric motors ranging in size from 25 h. p. downward.

The Frisbie Electric Elevator.

The accompanying cut represents a new direct electric elevator recently placed on the market, which combines some radically new features in this style of machine. Unlike all others the armature runs continuously at full speed, during the hours of work, which has the advantage of getting a high efficiency of the motor in starting the load with the lowest possible consumption of current.

The reversible motion is transmitted from the motor to the screw shaft by means of frictional gearing, which is practically noiseless and very effective in its operation, enabling the operator in the car to have such perfect control over the machine that the car can be moved to such a nicety as to be started and stopped within a fractional part of an inch.



THE FRISBIE ELECTRIC ELEVATOR FITTED WITH A C. & C. MOTOR.

The worm is cut from steel of selected stock. The worm wheel is extra heavy and cast from nickel bronze, making it very tough and durable. With a view of reducing the friction to a minimum a ball thrust collar is used. The drum is of large size, turned and grooved to fit the wire cables. There is a stop motion on the machine which enables the car to be run at full speed, and be stopped automatically at the end of the run.

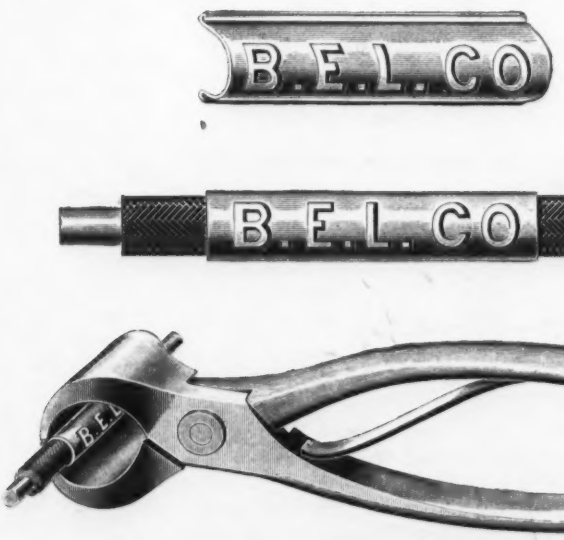
The slack cable stop, in the event of the car meeting any obstruction in its descent, engages a clutch on the end of the drum shaft, stopping the machine instantly and locking it so that the car can make no further descent.

In the event of the motor becoming impaired for any reason while the car is descending with a heavy load, the speed governor on the machine, operating by reason of the centrifugal force, throws out a friction clutch and puts on a powerful brake, stopping the machine instantly. Floor space is frequently quite an item, and this machine has the advantage of being very compact.

The motor is one of the well known "C. & C." Electric Motor Company's make, and is fitted with that company's new self-oiling bearings and carbon brushes. This motor is too well and favorably known to require any extended description. The apparatus can be run at a high rate of speed, and yet the car be started and stopped very smoothly. These machines are made by the D. Frisbie Company, of New Haven, Conn. This firm erects power elevators of all kinds, and has shipped them to all parts of the country, and this apparatus, the latest production of the company, will no doubt secure the same favorable reception that the company's other machines have always had.

A Wire Tag for Massachusetts Lines.

Since the enactment of the Massachusetts law requiring all overhead lines of wire to be tagged with the name of the company owning them, a number of simple devices have been placed upon the market in that State, by the use of which the operating companies might comply with the law. One of these devices is shown in the accompanying illustrations. It is manufactured and put upon the market by the Union Electric Manufacturing Company, of Bridgeport, Conn. Fig. 1 shows the actual size of the No. 1 tag as stamped with the initials of the Boston Electric Light Company. Fig. 2 shows the same tag after it is put in place upon the wire, while Fig. 3 indicates the method of applying the tag, together with the tool by which this is done. It will be seen that this metal tag is very simple in construction, is very easily applied and cannot be displaced under ordinary treatment when once firmly applied to the line.



FIGS. 1, 2 AND 3.—TAG FOR ELECTRIC WIRES.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

The Thomson-Houston Electric Company's stockholders are offered by circular opportunity to subscribe to an issue of $500,000 8 per cent. preferred stock of the Northwest Thomson-Houston Electric Company. The capital stock of this company is $750,000 common and $750,000 preferred. Of the latter, $250,000 will remain in the treasury of the company.

American Bell Telephone.—The *American Wool Reporter* presents the following table, showing the holdings of the American Bell Telephone Company's directors and some of the financial stockholders each year from 1886 to 1891, inclusive:

	Shares.					
	1886.	1887.	1888.	1889.	1890.	1891.
*W. H. Forbes	4,470	4,320	4,330	4,100	3,230	2,820
*A. Cochrane	528	400	300	300	180	200
*C. E. Hubbard	42	42	52	52	115	.....
*W. G. Saltonstall	200	200	200	200	150	.....
*J. E. Hudson	25	25	5	5	6	7
*Thos. Saunders	5	5	5	5	20	10
*Howard Stockton	.....	.....	100	25	25	.....
E. S. Converse	115	25	110	26	.....	25
*C. P. Bowditch	.....	303	303	203	200	200
W. F. Draper	100	100	100	102	102	102
Ed. Dwight	31	31	31	131	149	165
W. S. Fitz	154	158	178	320	320	320
A. G. Bell	1	1	1	1	1	1
M. G. Bell	2,038	1,900	1,890	1,700	1,784	1,700
W. R. Driver	35	15	15	5	8	5

* Directors.

In commenting upon these figures it is pointed out that when Col. Forbes had 4,470 shares, and Mr. Alex. Cochrane 528 shares, in 1886, the stock of the company was $9,802,100. Now it is $15,000,000.

Fluctuations in Boston Stocks for Six Months.—The following statistics of electrical stocks for the first six months of 1891 have been compiled by Joseph G. Martin, a Boston broker:

Year 1890. Low	Year 1890. High	Dividends. Payable.	Dividends. 91	Par.	Company.	Jan., 1891. Low.	Jan., 1891. High.	February. Low.	February. High.	March. Low.	March. High.	April. Low.	April. High.	May. Low.	May. High.	June, 1891. Low.	June, 1891. High.
191	240	Jan. 15	3‡	100	American Bell Telephone	‡184	220	185½	197	192	200	196¾	207½	198	207½	*189½	202
111	113⅛	F. & A.	3½	1000	American Bell Tel. 7's. '98	111	112	111	112	111	112	111	112½	112½	114⅛	111½	112¾
.....	.....	.....	.....	10	Detroit Electric Works	.....	.....	.....	.....	.....	.....	10½	13½	11	13⅛	9½	11¼
1½	7¼	None	.....	10	Edison Phon. Toy	1	2	1	1	1	1	.....	.....	.....	.....	.....	.....
37½	54¾	Feb. 17	1†	100	Erie Telephone	46⅝	50	47	49½	47½	50¾	48¼	50¾	*48	50¾	48	49
*10	15⅞	May. 15.	3	25	Fort Wayne Electric	10¾	12⅝	12	14	12	13	12¾	13½	*12	13½	11¾	12½
65c	1¼	None	.....	10	Mexican Telephone	70c	80c	65c	70c	80c	1.03⅛	85c	1.25	90c	1.22½	1⅛	1.35
27c	72½c	None	.....	5	National Telephone	32½	37½c	30c	35c	25c	25c	23c	27½c	18c	26c	22c	27½c
48	55	Feb. 15	1¼	100	N. E. Telephone	50	52	50	51	50	51	51	51½	*51	53	50	51
103½	106	A. & O.	3	1000	N. E. Telephone 6's	104½	105	104	105⅛	101	103¼	103	103	101	102½	101	102½
.....	.....	Jan. 1	†2a	25	Pettingell-Andrews Elec.	25	26½	25½	27¼	25	26⅛	*25¼	*25¾	.....	.....	.....	.....
35	69¼	Feb. 15	†4a	25	Thomson-Houston Elec.	42	49¼	44¾	49	41¼	45½	44	48	43½	47⅞	41	44
25	28½	Jan. 1	3½	25	Thom.-Houston El. pref	25¼	26	25¾	26	25	25¾	25¼	26	25½	26	*24⅞	25⅞
11	18	Mar. 18.	‡2½	.....	Thom.-Houston Series C.	.....	.....	11½	13	*9¼	12⅜	9¼	9½	9	9¼	8½	9
5½	8⅞	May 1	25c	.....	Thom.-Houston Series D.	5½	6	5¾	8	6½	7½	6¾	8	7	7½	7	7⅛
50	121½	.....	.....	100	Tho. European Welding	55	72½	60	72½	56	65	55	60	60	60	50	50
40c	1½	.....	.....	10	Tropical American Tel.	1¼	1¾	75c	75c	62½c	75c	85c	85c	50c	55c	60c	97½c
15	58	.....	.....	50	Westinghouse Electric	8	13⅛	11¼	17¼	10⅝	13	11½	15½	13	16¼	12	13⅜

* Ex. div. † qt. ‡ Ex. rights. *a* Same since.

The following table gives the highest and lowest prices for the same six months with the dates:

Stocks. 1891.	Date when Lowest.		Date when Highest.	
American Bell Telephone	‡184 Jan.	30	220 Jan.	14
Detroit Electric	9½ June	25	13½ Apr.	27
Erie Telephone	46⅝ Jan.	3	50¾ Apr.	1
Fort Wayne Electric	10¾ Jan.	5	15 Feb.	9
Mexican Telephone	65c. Feb.	3	1.35 June	8
National Telephone	18c. May	29	37½c Jan.	19
New England Telephone	50 Jan.	7	53 May	5
Pettingell Andrews Electric	25 Jan.	15	27⅝ Feb.	9
Thomson-Houston Electric	41 June	9	49¼ Jan.	31
Thomson-Houston Electric Pref.	*24⅞ June	24	26 Jan.	12
Thomson-Houston Elec. Series C.	*9 May	23	13 Feb.	9
Thomson-Houston Elec. Series D.	5½ Jan.	23	8 Apr.	22
Thomson-Houston Elec. Welding	140 Apr.	15	140 Apr.	15
Thomson-Houston Europ. Weld'g	50 June	27	72½ Jan.	8
Westinghouse Electric	8 Jan.	15	17¼ Feb.	7

* Ex dividend. ‡ Rights off.

The prices of the same stocks at the beginning and end of the six months together with the highest and lowest prices are given in the following table:

Stocks. 1891.	Jan. 2.	January to July. Low.	January to July. High.	June 30.
American Bell Telephone	*208	‡184	220	*188½
Erie Telephone	46¾	46⅝	50¾	48
Fort Wayne Electric	11	10¾	15	12
New England Telephone	51	50	53	50½
Pettingell-Andrews Electric	25	25	27⅝	*24
Thomson-Houston Electric	43	41	49¼	42½
Thomson-Houston Electric pref	25⅜	*24⅞	26	*25
Thomson-Houston Series C	11	*9	13	9
Thomson-Houston Series D	6	5½	8	7
Thomson European Welding	60	50	72½	50
Tropical American Telegraph	1	50c	1¼	80c.
Westinghouse	15	8	17¼	12½

* Ex dividend. ‡ Quarterly.

The Closing Quotations of electric stocks on Saturday, Aug. 15, 1891, in New York and Boston were:

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
NEW YORK.				
Western Union Telegraph Co	100	86,200,000	80¼	80⅜
American Telegraph & Cable	100	14,000,000	....	80
Central and South American	100	5,000,000	....	....
Mexican	100	2,000,000	....	....
Commercial Cable Co	100	7,716,000	104½	....
Postal Telegraph Cable	100	5,000,000	....	....
Edison General Electric	100	9,503,500	98	100
" " " Deferred	100	2,496,500	....	....
Consolidated Electric Light	100	1,529,400	....	....
Edison Electric Illuminating Co	100	2,567,800	....	....
United States Electric Light	100	1,500,000	....	....
North American Phonograph	100	6,200,000	....	....
BOSTON.				
Thomson-Houston Electric Co	25	6,000,000	40½	40½
" " preferred	25	4,000,000	24¼	24½
" " Series C	10	400,000	....	....
" " Series D	10	120,000	6¾	....
" International Co	100	1,000,000	....	....
Thomson Welding Co	100	1,000,000	....	....
" European Welding Co	100	1,000,000	....	....
Ft. Wayne Electric Co	25	4,000,000	11½	11¾
Westinghouse Electric Mfg. Co	50	5,000,000	....	....
Telephone:				
American Bell	100	12,500,000	179	....
Erie	100	4,800,000	....	45½
New England	100	10,304,600	49	....
Mexican	10	1,280,000	1.05	....
Tropical American	10	400,000	.50	....
Edison Phonograph Doll	10	1,000,000	.50	....

Chicago Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone and electric light stocks as follows:

TELEPHONE STOCKS.

Chicago	$230@	$240	Cumberland	$60@	$62
Central Union	52@	53	Wisconsin	118@	120
Michigan	83@	84	Bell of Missouri	160@	165
Great Southern	30@	32	Iowa Union	20@	22
Colorado	34@	36	Missouri and Kansas	54@	56
Rocky Mountain Bell.	40@	43			

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$95@	$100	Chicago Edison Co	$145@	$150

NEW INCORPORATIONS.

The Home District Telegraph Company has been organganized at Seattle, Wash., with a capital stock of $50,000. Its incorporators are Samuel J. Stillwell and James L. Clancy.

The Citizens' Electric Light Company, with a capital stock of $25,000, has been incorporated by I. N. Rogers, W. L. McCoy, Charles Gudgell and W. A Cunningham.

The Great Falls Electric Light and Power Company has been incorporated with a capital stock of $150,000, by Albert Bigelow, Clarence H. Bissell, C. Parsons, Edgar Buffun and Lewis Hart.

The Enterprise Electric Light and Railway Company, with a capital stock of $100,000, has been organized, and proposes to operate an electrical street railway on Schuyler avenue and other streets in Kankakee, Ill.

The Portable Electric Light and Power Company has been organized to manufacture carbons, cups, etc., for the primary batteries to be used in lighting by the Wright system. The factory of the company will be in Denver, Colo.

The Electric Light, Street Railway and Power Company has been organized at Creal Springs, Ill., with a capital stock of $6,000, to operate an electric light plant. W. DeBolt, C. L. Otrich and W. S. Carroll are the incorporators.

The Kansas Fuel Gas Company, of Chicago, Ill., with a capital stock of $1,000,000, has been organized to furnish electricity for light, heat and power. Thurston Gorden Hall, Jno. A. Campbell and Jno. H. Carruther are its incorporators.

The Brighton Water and Electric Light Company, of Brighton, Col., with a capital stock of $20,000, has been organized to supply the town of Brighton with water and electric lights. William H. Malone, Willard C. Kidder and James McKeon are the incorporators.

The Fall River Electric Gas Machine Company, of Rockford, Ill., with a capital stock of $50,000, has been formed to manufacture and sell gas and electric lighting machinery, and gas and electricity. Geo. D. Roper, Geo. S. Roper, and W. W. Wonser are its incorporators.

The Wagner Electric Manufacturing Company, of St. Louis, Mo., has been incorporated, with a capital stock of $25,000, to manufacture, hire and sell electric apparatus, machinery, supplies, etc. The promoters are H. A. Wagner, E. G. Ellis, A. Blair and F. Schwedtmann, of St. Louis.

The Hughesville Electric Light and Power Company, of Hughesville, Pa., with a capital stock of $10,000, has been formed to supply electric light and power to the public in Hughesville. Chester E. Albright, M. D., J. Sellers Kite and Frank Cheyney, all of Philadelphia, are its incorporators.

The Citizens' Fuel, Light and Power Company, of Celina, Cal., has been organized with a capital of $50,000, to produce, purchase and sell oil, gas and electric light and power, etc. Its promoters are A. F. Marsh, S. S. Scranton, Joseph May, T. P. Touvelle, D. Rush, J. M. Lisle and A. L. Bohrer.

The Contractors' Supply Company, of Chicago, Ill., has been incorporated with a capital stock of $1,000,000, to conduct a general merchandise and supply business, and operate steam, heat power, light and water supply plant. Theo. Burkhard, Judson Lattin and A. W. Cain are the promoters.

The Lebanon (Pa.) Manufacturing Company has been organized with a capital stock of $10,000, for the purpose of making and selling pneumatic and electrical supplies. It is incorporated by Anthony A. Lehmann, Albert Goldstein, Philip R. Vogel, Jr.; Abraham Lehmann and D. K. Este Fisher.

The Middletown Electric Street Railroad Company, of Middletown, O., with a capital stock of $100,000, has been formed to operate an electric street railroad. H. Knight, H. P. Lane, J. M. Schenck, H. H. Hatch, Murray Schenck, Henry Behrens, W. T. Harrison and M. A. Thomas are the incorporators.

The Washington County Electric Light and Power Company, of Troy, N. Y., with a capital stock of $10,000, has been organized to furnish electricity for light and power in Cambridgeport, Shushan and Salem, N. Y. Its promoters are Dagobert Zieser, of Troy, N. Y., and F. O. Lovejoy, of Shushan, N. Y.

The Kinsley Wright Electric Elevator Company, of Denver, Colo., has been organized with a capital stock of $25,000, for the purpose of manufacturing and constructing electric, hydraulic, steam and hand elevators, and setting up and putting the same in place. Parvin Wright, S. W. Wright and John C. Fyfe are the promoters.

The Buffalo and Williamsville Electric Railway Company, of Williamsville, Erie county, N. Y., with a capital stock of $50,000 has been formed for the purpose of operating a street surface railroad. Hascal Taylor, John Scatterfield, R. F. Parsons, Freeman M. Vidas, all of Buffalo, and James Chalmers, of Williamsville, are its promoters.

The Pneumatic and Electric Tool Company, of Jersey City, N. J., has been formed with a capital stock of $300,000, to manufacture, sell and let pneumatic and electric tools and all improvements on and substitutes therefor. E. Baldwin, New York City; E. Max, Brooklyn; J. Griffin, Jersey City, and A. F. Blackner, are its incorporators.

The Portland and Southern Railway Company, of Portland, Ore., has been incorporated with a capital stock of $10,000,000, to build, buy, sell, lease, etc., all means of transportation and communication, by land and water, including horse, steam or electric lines. Its incorporators are Frank Sperling, W. S. Mason and Mose Meyer.

The Edison Electric Light and Power Company, of Fresno, Cal., has been organized with a capital stock of $100,000, to prosecute the business of producing, manufacturing and supplying electricity for light and power. Jno. M. Ryan, Louis Gundelfinger, William Fahey, W. Degen and W. McCullem, all of Fresno, are the promoters.

The Columbian Electric Light, Power, Heat and Manufacturing Company, of Jersey City, N. J., has been incorporated with a capital stock of $1,000,000, to purchase, own, manufacture, operate and sell patented and other devices, etc., etc., for producing applying and utilizing electric light, heat and power. Julius Hirshfield and William Wright, of New York City, and A. P. Morrison, of Montclair, N. J., are the promoters.

The Citizens' Passenger Railway Company of Mt. Pleasant and Tarrs, Pa., with a capital stock of $18,000, has been organized for the purpose of constructing an electric line to connect the two places. The following gentlemen are interested in it: D. S. Jordon, William D. Mullin, Charles E. Mullin, Robt. H Goodman, L. S. Tintsman and William F. Smith, of Mt. Pleasant; Emil Swenson, of the Keystone Bridge Co., Pittsburgh; James S. Bascom, of Greensburgh, and H. J. Jordon.

AFFAIRS OF THE COMPANIES.

The Western Union Telegraph Company's test office receipts for the week ending Aug. 8 showed a falling off of $8,000, the first week of August, 1890, being the heaviest of the company's history, amounting to $265,000.

The Braddock and Turtle Creek (Pa.) Railway Company has opened its books for an increase of capital stock from $100,000 to $130,000. The company intends to extend its line to Wilmarding and to Keating Station.

The Monticello (Ia.) Electric Company's directors held a meeting last week, and elected Messrs. D. L. Davis and D. E. Pond to the vacancies on the board caused by the resignation of Messrs. H. L. Carpenter and George L. Lovell.

The Municipal Electric Light Company, of Brooklyn, has chosen the following trustees: Matthew Dean, James L. Sensen, G. Edward Graff, John Hills, Bernard Gallagher, Clement Lockitt and Ezra D. Bushnell. Their term is for one year.

The Penacook (N. H.) Electric Light Company has elected the following officers: Charles H. Sanders, George W. Abbott, E. E. Graves, E. H. Brown and W. W. Allen. The board organized with president, Charles H. Sanders; treasurer, E. H. Brown; clerk, W. G. Buxton.

The Plymouth (N. H.) Electric Light Company has organized with a capital of $10,000. At a recent meeting the following officers were chosen: President, Merrill Greeley; secretary, Perley S. Currier; treasurer, John Mudgett; directors, Merrill Greeley, Warren G. Chase, Cyrus Sargent, Joseph C. Story and D. B. Keniston.

National Telephone Manufacturing Company.—The annual meeting of the stockholders of the National Telephone Manufacturing Company, was recently held at Portsmouth, N. H. The following board of directors was elected: S. K. Roberts, Woodward Emery, L. B. Russell, James D. Leatherbee, John B. Bennet. The report of the treasurer showed that the company could pay all of its indebtedness with a handsome surplus, besides holding nearly 10,000 shares of stock in the treasury.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Aug. 17, 1891.

The Fibrone Manufacturing Company, of 300 Monroe street, New York City, has been placed in the hands of the sheriff. This company was incorporated in January, 1890, with a capital of $60,000, which was increased in March last to $100,000. Mr. Thomas H. Wheeler, the largest judgment creditor, is a director of the company, and is of the firm of Hyde, Wheeler & Co., of Boston. On July 25 the company gave Mr. Wheeler a chattel mortgage for $14,750 on the machinery.

Trial of the Sims-Edison Torpedo.—The official test of the new Sims-Edison electric torpedo, just completed for the United States government, took place last week at the government torpedo station, Willets Point, and the results attained were extremely satisfactory. The run was made for the purpose of testing the speed of the craft, the tests for driving and other evolutions to be held later. The boat on trial in this case is the latest invention in the line of electric fish torpedoes. It is driven, steered and discharged by electricity. It has a cable of high insulation and two and one-third miles in length, being over 1,000 feet longer than any of the 10 boats heretofore built for the Government by this company. The Sims-Edison weapon has attained its great importance on account of its speed, the torpedo just built having about twice the speed of any other made by the Sims-Edison company. The government was represented at the trial by Col. W. R. King, in charge of the torpedo station at Willet's Point, and the exhibition was witnessed by a number of army and navy officers, representatives of foreign governments and prominent electricians. The launching of the submarine boat was the work of only a few minutes, and W. Scott Sims, the co-inventor with Edison of the torpedo, at once began to manipulate the apparatus. The missile darted off at a high rate of speed. So rapidly did it go that the float was constantly submerged, and when it was a distance of 2,000 feet from the dock all that was visible was the tiny United States flag at the stern. The boat exceeded all former speeds of government torpedoes by making 20 miles an hour, steering to the right and left or any desired course, and slowing down at the will of the operator. It forged ahead a distance of about 4,500 feet, was steered in a semicircle, and then returned to the starting point, Mr. Sims bringing

the torpedo to a full stop in front of the spectators. It had traveled about 12,000 feet in about six minutes, the time averaging 20 miles an hour, or two miles more than the contract with the government requires. The success was complete, no defect whatever having been discovered in the torpedo craft.

Removal of the Elektron Company to Springfield, Mass.—The business of the Elektron Manufacturing Company, of Brooklyn, and the reputation of Perret motors and dynamos has steadily increased from the start, although the business has been maintained in a more conservative way than is sometimes the case with electrical concerns. Now, however, the facilities are to be enlarged and improved in order that it may be able to meet the demand for its goods. As a first step to this end, the stockholders recently voted to increase the capital stock from $100,000 to $200,000, and the new stock was sold for cash at par. This places the Elektron Manufacturing Company well up in the front rank as regards financial standing as well as in extent of production. The company has taken the property on State street, in the city of Springfield, Mass., heretofore known as the Bullard Repeating Arms Works, and is now moving its manufacturing business there, an undertaking of considerable magnitude, a train of 12 cars being required. The property consists of a brick building, 52 feet × 40 feet, four stories high, with a three-story brick wing 125 feet × 40 feet. It is expected eventually to build on another wing of the same dimensions. The power plant is contained in a brick building adjacent to the main building, and consists of boilers and engine of 100 h. p., so arranged that an additional 100 h. p. may be put in whenever it is required. The buildings are all of elegant and substantial construction, and are supplied with every modern convenience. They are quite close to the tracks of the N. Y. & N. E. R. R.; from which a side track will be run in, so that no trucking will be required. The entire lower floor will be devoted to the machine shop, the second floor to offices, and to the shipping, assembling and testing departments; the third floor to the draughting, winding and insulating departments; on this floor will also be placed the store and show rooms. It is intended to make this a model plant. The organization of the company will continue as now. Mr. Wm. D. Sargent, of Brooklyn, is president; E. H. Cutler, general manager and treasurer; and Frank A. Perret, chief electrician. Mr. W. E. Wright, of the firm of McIntosh & Co., Springfield, Mass., has been added to the board of directors, and the manufacturing department has been strengthened by the appointment to the position of general mechanical superintendent of Mr. Leon J. Harley, recently superintendent of several departments of the Smith & Wesson Pistol Works, of Springfield, Mass. The general office of the company goes to Springfield, but for the convenience of patrons in New York City and vicinity, an office, storeroom and work shop will be maintained there, and a portion of the building No. 89 Liberty street, New York City, is now being fitted up for the purpose. The whole building will be lighted by the Perret system, and an opportunity will thus be afforded for examining both Perret dynamos and motors in practical operation. Mr. Robert Watson, who has been with the company two years as expert and selling agent, will have charge of the New York office. Mr. Cutler will divide his time between Springfield and New York. L. H. H.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 28, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., Aug. 15, 1891.

Mr. John Martin, an employé of the Malden Electric Company, fell from a pole on Thursday last and fractured one of his arms.

Mr. Wm. Crawford, of the American Circular Loom Company, has started on his annual vacation, which will be spent at Denmark, Me.

Mr. Geo. F. Talcott, the genial representative for the Simplex Electrical Company, has just returned from his summer outing, looking as brown as a berry.

The West End Street Railway Company is setting poles the entire length of Tremont street, and it is expected that this entire line will be equipped electrically in a short time.

Mr. A. L. Daniels, formerly with the Eureka Tempered Copper Company and now with the Mitchell-Brant Copper Company, of Erie, Pa., was in town this week and reports business as brisk in his line.

The H. A. Williams Manufacturing Company is moving into its new office at 334 Congress street, where it will occupy the whole building, consisting of six stories fitted up especially for its use, the change being made imperative by the increasing business of the company.

The Tripp Manufacturing Company, of 180 Summer street, Boston, Mass., manufacturer of electric cable and steam car apparatus, is to have a large factory at South Framingham, Mass. The new factory will be a frame structure, one story high, with nearly 15,000 square feet of floor space. It is expected that the building will be ready for use by Oct. 1.

Mr. J. E. Wallace, manager of the railway department of the Eastern Electrical Supply and Construction Company, has just returned from a trip through New England, and will immediately start on a trip through the West and South. Even in this hot weather business is brisk with this enterprising house, and its managers are working early and late filling orders.

Electrical Forging.—Prof. Van der Weyde, of Cooper Institute, New York; Dr. W. H. Wahl, secretary Franklin Institute, Philadelphia; Prof. West, of Pittsburgh, and C. E. Robinson, of the *Manufacturer and Builder*, of New York, witnessed some very interesting experiments at the Electrical Forging Company's factory, 136 Oliver street, Boston, on Thursday last. These experiments were in heating and forging metals and tempering by electricity. The alternating current generator or heating apparatus is of a peculiar design, built especially for the Electrical Forging Company, the capacity being 60 h. p., and furnishing a current capable of heating a bar of steel or iron eight inches long and one inch square, its entire length, to a white heat in 20 seconds. The speed of the generator is about 650 revolutions per minute, giving an E. M. F. of 1,600 volts. Current is passed from the alternator through a converter which reduces the voltage and increases the intensity of the current to 10,000 or 12,000 ampères. One of the experiments was the heating and rolling of some balls about half an inch in diameter. These balls were rolled from a bar of steel, and after being tempered several were broken and all found to be not only perfectly solid but of uniform density. C. A. B.

WESTERN NOTES.

Branch Office of The Electrical World,
465 The Rookery, Chicago, Aug. 15, 1891.

Quincy, Ill.—The electric light company names $105,000 as the price at which it will sell its plant to the city.

Morrelton, Ark.—The new electric light company has received its engine and will soon advertise for the electric machinery.

Youngstown, O., has been advertising for bids for lighting the city by electricity. The time for closing was placed at Aug. 10.

Beardstown, Ill.—The electric light company has increased the capacity of its plant. The company now operates five miles of line.

Mr. John Guedelhoefer, 175 West Georgia street, Indianapolis, Ind., is building several wagons to be used in constructing the overhead lines of Tho..son-Houston electric railways.

Bushnell, Ill.—On Monday morning of last week the boiler of the Bushnell (Ill.) electric light plant exploded and killed two men, the electrician and the fireman. The building is a complete wreck. The plant had been in operation only since last September. The boiler was of 60-h. p. capacity, and was built by the Frost Manufacturing Company, of Galesburg, Ill. The engine was of the Ideal type, running a 30-light arc machine and a 500-light incandescent. One-half of the boiler with most of the tubes was thrown about 500 feet, the other half being thrown in the opposite direction. The explosion was heard at Macomb, a distance of 11 or 12 miles. The dynamos were ruined and the engines very seriously damaged.

A Big Cable Contract.—The Standard Underground Cable Company, of Pittsburgh, Pa., has been awarded a contract for the entire system of underground cables to be used by the Minneapolis Brush Electric Company, of Minneapolis, Minn. The cost for the work to be completed by Dec. 1 is in the neighborhood of $92,000, while the total cost when the projected additions are made will be about $120,000. Over 80 miles of cable will be used. Six other companies placed bids for the work but the good record made by the Standard Underground Company's cables secured for it the award mentioned. Mr. S. B. Fowler, who is now in charge of the cable laying for this company in New York City, goes to Minneapolis this week and will at once begin active work in laying the cable. F. de L.

Kansas City, Mo., Aug. 13, 1891.

Mr. W. T. Osborne, the well-known electrical engineer, is on the sick list.

Mr. A. M. Barron, superintendent Home Telegraph Company, has resigned to engage in other business.

Mr. S. F. B. Morse, grandson of Prof. S. F. B. Morse, of telegraph fame, is a welcome visitor this week.

Mr. H. E. Webb, of the Solar-Carbon Manufacturing Company, of Pittsburgh, Pa., was in Kansas City this week.

Wire Thieves.—The telegraph companies are suffering from the depredations of petty thieves, who have succeeded in carrying off large quantities of copper wire.

Mr. Edward Lasell, president Southwestern Electric Supply Company, and Mr. Thos. Clohey, the well known electrician, made flying trips to St. Louis last week.

W. T. Osborne & Co. have secured the contract for wiring the Grand Opera House with National india rubber wire, furnished by the Southwest Electric Supply Company.

Mr. Chas. K. Sherman, who is connected with the business formerly carried on by the Sprague Electric Railway and Motor Company, is in Wichita, Kan., on a busness trip.

A New Electric Light Plant.—Bids will shortly be made on the electric light equipment for the new county court house, and as the contract is a large one some lively competition may be expected.

Mr. Geo. W. La Rue, secretary and general sales agent Crocker-Wheeler Motor Company, is here. Mr. La Rue is on a general Western trip for the purpose of making the acquaintance of his agents.

The Missouri and Kansas Telephone Company has under construction a line from Hiawatha, Kans., to Falls City, Neb., which will place the latter city in telephonic communication with Kansas City.

Judge R. C. Macbeth, president and general manager, and S. J. Duncan, electrician, Clinton Gas and Electric Light Company, Clinton, Mo., made us a visit last week. This company now operates 75 arc and 650 incande scent lamps.

The Jasper County Electric Company, located at Webb City, Mo., with a capital stock of $150,000, was placed in the hands of a receiver last week for the purpose of getting the business in shape to sell to St. Louis capitalists. Mr. Geo M. Myers, of this city, was appointed receiver. This company was organized about a year ago by W. P. Munro and Thos. H. Clohesy, who own the entire stock. The plant is well equipped throughout and furnishes light and power for the lead and zinc mines. When the new company takes hold, the capital stock will be increased to $300,000, and the capacity to 1,500 h. p. H. D. E.

SOUTHERN NOTES.

Norfolk, Va., Aug. 15, 1891.

Bluefield, Va.—The Graham-Bluefield Electric Company has been organized for the purpose of erecting an electric light plant at this place.

Leesburg, Va.—Sealed proposals will be received by Mayor H. O. Clagett until Aug. 29, for lighting the streets of Leesburg by electricity.

Ft. Worth, Tex.—Templeton & Carter have filed a suit in the district court against the Detroit Electrical Works for debt in the sum of $2,000.

Roanoke, Va.—Mr. W. K. Kirnan, the electrician of the Gamewell fire-alarm system, has been making several tests recently endeavoring to get his alarm working properly.

Montgomery, Ala.—Negotiations are now under way for the building of an electric street car line. Work will begin within a short time, and the cost of the road will be $80,000.

Pass Christian, Miss.—An electric light plant will be established in this city by the Pass Christian Electric Light Company. Mr. C. M. Rhodes, secretary of the company, would like prices on machinery.

Huntsville, Ga.—The Nordyke & Noran Company has filed a bill to foreclose the mortgage on the Huntsville Electric Light Company and to have a receiver appointed. Mr. C. F. Sugg has been appointed receiver.

East Rome, Ga.—The contract for the erection of an electric light plant in East Rome has been let to the Rome Gas and Electric Light Company. Work upon the plant, which will be of both arc and incandescent, will begin at once.

Newport News, Va.—Surveys for the electric road to run from Newport News to Old Point have been completed, and work on the Newport News end of the road will be commenced after the track has been laid through the government reservation of Old Point.

Taylor, Tex.—The City Council has been in correspondence for some time with a party in the East who is desirous of locating an electric light plant in the city. It is understood that several citizens of the town are interested, and that the establishment of the system is an assured fact.

Columbus, Ga.—Mr. Eugene P. Lynch, Jr., of New York, arrived in Columbus recently. Mr. Lynch has the contract for the construction of an electric car line from the corner of Eleventh and Broad streets to the proposed park of the North Highlands Improvement Company. A force of one hundred hands is now at work upon the line, and the company expects to have it completed within the next 90 days.

Richmond, Va.—The Southern Bell Telephone Company will present for consideration before the Street Committee at the next meeting of the City Council the recommendation of an ordinance which will grant the privilege of placing its wires underground on the several streets of Richmond in conduits, with manholes and other necessary approaches and appliances under the supervision of the city authorities. The ordinance also provides that the company shall put the wires of the city underground, such as police and fire-alarm telegraph wires, without any charge, and at least one conduit shall be set aside for the use of the city. It is estimated that the cost of making an underground system would cost the Bell Telephone Company the sum of $100,000.

Washington, D. C., Aug. 15, 1891.

The annual convention and joint reunion of the Old Time Telegraphers' Association and the Society of the United States Military Telegraph Corps will be held in this city on the 19th, 20th and 21st of August. The Ebbitt House has been selected as the headquarters of the societies. Many members from all over the country will be present, among them being Anna Ellsworth, now the wife of Mr. Roswell Smith, president of the Century company. Miss Ellsworth was the person who sent the first telegraph message over Morse's line, between Washington and Baltimore. The membership includes those who did the telegraphing for the army during the civil war, and others who were engaged in the business between the years 1844 and 1869. The Old Timers admit to their membership only those who have handled the key for at least 20 years, and as the Military Telegraphers include only those who were on duty in connection with the military telegraph during the war, the members of that association, too, are veterans in the service. The list of those who have risen from the telegraph ranks to exalted position in the business world is long, but even longer is the roll of those who were in the telegraph service before and during the war and who are still interested in telegraphy. Washington, which was the headquarters of the military telegraph of the government during the war, has a large share of these men with histories, who will welcome their comrades on next Wednesday. There are two telegraph operators in Washington who were linemen on the original Morse telegraph line between Washington and Baltimore in 1844. One of them is Alexander Borland, a clerk in the Treasury Department, and the other Paul D. Connor, chief of repairers for the Western Union Telegraph Company in this city. Mr. Connor helped construct the local system of government telegraphy during the war, and ran wires into the War Department and the Executive Mansion. He was in the confidence of the other managers of the government system. He stood beside Mr. Lincoln in the Soldiers' Home when the department clerks repulsed the Early raiders in their attack on Washington. Another historic character is John McGovern, a sporting man, who gave up the telegraph many years ago, and who is a familiar figure in Washington. McGovern claims to have sent the last despatch that went south from Washington before the wires were cut. Jack Lombard, who is now with the Western Union Telegraph here, was the only operator on duty at Baltimore during the riots of April 9, 1861. He worked the one wire running from Baltimore to Washington which through an oversight was not cut by the rioters, and he kept the War Department advised of what was going on. Morrill Marean, who is the manager of the Western Union here, was chief operator for the American company during the war. Fred Royce was also with the American company during the war. He is now associated with Mr. Marean in the telegraph supply business here. William Glasscott, a business man of this city, worked on the military telegraph during the war, as well as F. T. Bickford, of the Agricultural Department. All of these "old timers" tell many thrilling stories of their adventures 25 years ago. V. N. B.

CANADIAN NOTES.

Toronto, Can., Aug. 15, 1891.

The Toronto Incandescent Light Company, of Front street, is doing quite an extensive business in the supply line, but little work otherwise is coming in.

The Toronto Electrical Works, of Adelaide street, West, through Mr. Thornberry, who is an old New Yorker, and who is manager of the company, reports business to be very fair. The company has a very well fitted up factory and shop, where an extensive business in the manufacture of insulated wire and in general repairing is carried on.

The Edison General Electric Company, of Bay street, has been in its new building but a short time, yet it has managed to fit it up in excellent style. It is a five-story brick and brown stone building, the first floor being given over to stockrooms and salesrooms—both extensive and showing a large assortment of all kinds of electrical goods. On the second floor are conveniently arranged offices for such clerical help as is needed, together with the general managers and district superintendents. The remainder of the building is arranged for manufacturing, draughting, etc. Finished throughout as it is in light woods, the effect is very pleasing. Mr. Brenner, the district engineer, reports work quiet and no new contracts.

The Toronto Street Railway Franchise has just been awarded to the "Kiely-Everett" syndicate of Cleveland, O. Up to the present month the car service has been a government institution, and many of the cars are in a bad state. No particular system has been pursued by the city in running the road, and in consequence there are long cars, short cars and open cars of every possible hue known. The Kiely-Everett syndicate proposes to put in an electric service, and most of the electric companies in the city are on the "qui vive" regarding contracts for construction, etc. It is but fair to say, however, that the principal competition will be between the Ball Electric company using either the Wenstrom system or storage batteries and its own motors, and the Edison General Electric Company, which will probably use a system of its own, a sort of a Sprague-Sperry combination. It is hoped by every resident in Toronto that the day of horse cars is done, and that rapid transit is approaching the city.

The Ball Electric Light Company, Ltd., of Pearl street, is probably one of the oldest companies in Canada, having been engaged in the business since 1882. The company occupies extensive quarters in a four-story brick building. Mr. W. A. Johnson, the superintendent, says he finds business very quiet; he considers electric lighting in Canada at least to be in its infancy. His company proposes, in connection with the Roberts Storage Battery Company,

to equip a car and place it on trial. He has seen about all of the systems now in use, and thinks the storage battery has never been given a fair showing. The Ball company manufactures a very durable dynamo and motor, and its machines are in use in many Canadian towns. Its dynamos are noted for their steadiness, and the managers consider the durability of the dynamos to be due to the fact of their using a perfect Gramme armature in a double form. They also manufacture lamps, fixtures, search lights, etc., and are agents for the manufacture and sale of the Wenstrom dynamos and motors.

Better Work Needed.—One might say in very truth that the Canadians were rather conservative. Capital is needed, and many of the electricians in Canada are complaining because money is so scarce. Everything in Canada is crowded "way down," owing to a low tariff, and in consequence the question of wages, with most companies, has been considered until, to use a slangy expression, it's "out of sight." Therefore, the largest factor in an electric light company's business, the lineman, suffers most, and in consequence the work suffers also. Instances in proof of this assertion can be daily pointed out. One cannot go on a business street without seeing plenty of poor wiring. One of the largest buildings, lately wired, gives evidence in my favor, from the fact that rarely will more than one floor light at one time, and repairs are going on continually. It is to be hoped that the new street railway syndicate will not fall into this rut, but will, by clean management, put the electric light trade in Canada, and especially in Toronto, upon a better foundation. Many of the smaller plants visited by your correspondent showed the effects of poor management, being dirty, and the lights not better than red hot hairpins.

The Roberts Storage Battery Company is located on Adelaide street, West, where an extensive business in the manufacture of batteries for all purposes is carried on. The company has just received, in connection with the Edison company, a contract for supplying the Upper Canada College with a 120-cell plant, including all necessary switches, equalizers, etc. Ex-Alderman E. A. McDonald has also placed a contract in the company's hands for a large installation at his residence in Bellamy, a suburb of Toronto, where the power will be secured from a windmill. The Hall Phonograph Company is also an extensive user of the batteries. The company has other incandescent lighting contracts on hand, and seems to be quite busy. Its electric launch, the "Electroneus," which has just been placed on the lake is worthy of notice, being the only boat of its kind in Canada. It was built by Mr. Lorchs from designs furnished by Mr. G. H. McFarlane, manager of the company, and is 26 feet over all, with a six-foot six-inch beam. The power is furnished by 60 two-volt cells to a "Kay" shunt wound three-h. p. motor, which is coupled direct to the screw by a ball joint. The batteries, together with the motor, are neatly boxed in, and serve as ballast. When connected in series, four h. p. is developed and a speed of eight miles per hour, while coupled in multiple form three h. p. is developed, and one charge will last a day. The jars are made of rubber, so no breakage can occur. The Toronto Electric Light Company furnishes the charge at a rate of 20 cents per hour. The rudder is connected by chains to a small wheel in the bow, where are situated also the reversing switch, an ammeter and a voltmeter. The boat also carries an outfit of five 10-candle incandescent lamps that serve to brilliantly illuminate it at night. Mr. McFarlane says that by using the "automatic speed regulator" the speed can be varied from 4 to 10 miles per hour. The "Electroneus" is finished in oiled pine. The estimated cost with a direct-acting motor complete is $1,100, and geared motor $100 extra. Mr. Roberts considers his battery plate, which is of peculiar construction, as nearer perfection than anything ever brought out. Already the batteries are being used in hospitals, especially in surgical operations, etc. The E. M. F. of the cells of any form is about two volts per cell, and may rise to 2.7 volts.

J. C. A.

MONTREAL, August 14, 1891.

A German Exhibit at Montreal.—The exhibition committee of the National Electric Light Association has received a cable message from Messrs. Calm & Bender, of Berlin, announcing the shipment of an exhibit to be shown at the Montreal convention in September.

General Barney, who has been appointed by the Executive Committee of the National Electric Light Association to take charge of all matters in connection with the coming exhibition, reached here late last night and was early at work this morning. The General's past experience with this kind of thing will help him very much, and from what I can see of the magnitude of the exhibition he will need all of his experience. It is certainly going to be a big affair.

The Citizens' Executive Committee held a meeting last night in the Windsor Hotel, over which Vice-Chairman John Kennedy, Esq., presided. Messrs. H. Linnell, A. J. Corriveau, James Kent, W. E. Christie, F. Fairman, R. White, W. H. Laurie, L. W. Tom and E. C. Arnoldi were also present. A letter was read from the Bell Telephone Company offering to place some of its instruments at the disposal of the committee during the exhibition free. Another communication conveying good news was to the effect that the management of Sohmer Park would admit free, on the production of badges, all members of the association, and visitors, to a special promenade concert. It was also decided to insert on the programme yachting excursions, to which all the lady visitors and their friends are to be invited. The trip will be from Iberville up the beautiful Richelieu River to "Isle aux Noixs," on which is the historic Fort Lennox, surrounded by a moat, passing on the way up the military barracks, now occupied by the Canadian permanent militia under the command of Lieut. Count D'Orsonent. The vessels are the steam yachts "Alexandria," owned by Alex. Macdonald, ex-commodore of the Montreal Yacht Club; "Nirvana," owned and commanded by Madame Louis Givernaud, of New York, and the "Adonis," owned by Commodore J. B. Fressider, of Iberville.

The Sub-Committee on Exhibits held a brief meeting this morning. There were present the chairman, Mr. F. R. Redpath, Prof. Bovey, Mr. A. J. Corriveau and General Barney. A very important matter decided was that of reserving certain nights for the benefit of the working classes at a reduced admission fee of ten cents; this is one of the best things that could have been done, and will be fully appreciated. It is further proposed, if possible, to keep the exhibition open a little longer than the specified time. This would be another good move and should go through. Active preparations are being made for the exhibition itself, a new and heavy floor is being laid in the exhibition building, and men are at work stringing wires to transmit power from the McGill University. The interest in the coming event is growing daily.

CIRTCELE.

ENGLISH NOTES.

LONDON, Aug. 5, 1891.

City and South London Railway.—According to the report of the directors of this company for the half year ending June 30, the receipts for that period have amounted to close upon £20,000, and the expenses to £15,500, leaving a net profit of nearly £5,000, which is practically only sufficient to pay the interest on the debentures. During the half year the number of passengers carried by the railway was close upon 2½ millions.

The British Association.—The forthcoming meeting of the British Association at Cardiff does not seem likely to prove a particularly successful one, at any rate from the electrical point of view. The place of meeting is not by any means attractive, and the middle of August is scarcely the time of year for the discussion of abstruse scientific questions. Moreover, the president-elect is an astronomer. On the other hand, Dr. Oliver Lodge, being the president of section A, his address can scarcely fail to be interesting, although it is improbable that it will contain anything startling. The proposed discussion on "Units and Their Nomenclature," should it come off, will perhaps be the most prominent feature of the meeting. The general consensus of opinion is that the date chosen is an unfortunate one and a better meeting may be anticipated next year at Edinburgh, when it will be held at the very end of September, just before the commencement of the academic year when the professors who contribute so largely to the success of the British Association meetings, will have returned from their holidays in a state of complete rejuvenescence.

Experiments with Condensers.—M. Maurice Leblanc has, in conjunction with M. Hutin, recently devoted himself to alternate current researches with the result that an alternate current system of distribution has been evolved, in which condensers play a large part. At the recent meeting of the Société Internationale des Electriciens, M. Leblanc gave a brief but interesting account of his difficulties with condensers. The materials he first of all employed were common paper soaked in ordinary paraffin wax. When, however, high alternating potentials were applied to these, they soon gave out and no perceptible improvement was observable when the best materials were used. M. Leblanc, therefore, reverted to common paper and common paraffin, but he boiled his paper in paraffin several hours previous to building up the condensers. The specific inductive capacity of the dielectric fell under this process from the original figure of eight to as low as two. Condensers, however, constructed in this way proved themselves very satisfactory in practice. But as this method of construction was extremely costly, M. Leblanc again took up the first discarded batch, which before throwing aside, he had very severely used by subjecting them to very high potential differences. To his surprise he found that the specific inductive capacity of the dielectric had fallen to about 2½, but on the other hand there was little or no "soakage," and the condensers had now become seasoned and excellent for practical purposes. M. Leblanc therefore points out that we may use the commonest materials in the construction of commercial condensers, and they will prove satisfactory so long as they are submitted to a previous process of "forming." M. Leblanc prefers on the whole to use ebonite as a dielectric. He has succeeded in obtaining ebonite sheets of .2 millimetre thick, capable of withstanding alternate potentials of nearly 11,000 volts. He gives as a practical rule, that all is well so long as the condensers do not "hum," but the moment they do, they must be cut out of the circuit.

News of the Week.

THE TELEGRAPH.

Aberdeen, Wash.—The Western Union Telegraph Company has opened an office in Aberdeen for commercial business.

Ashland, Wis.—The Ashland office of the Western Union Telegraph Company does a larger business, it is said, than any other office in the State outside of Milwaukee, handling on an average 1,500 messages a day.

Minneapolis, Minn.—The Western Union Telegraph Company failed to make satisfactory arrangements with the Soo company, which controls the right of way for telegraph conduits on Third street, and has decided to lay its conduits alongside those of the Soo.

A Telegraph System for East Africa.—A telegram from Berlin says that the government has decided to establish a complete telegraph system on the German East Africa coast, and that official started on the 10th inst. from Berlin for Africa, where they will proceed to organize the system.

Santa Ana, Cal.—The old telegraph line of the Western Union from Santa Ana to San Diego is to be abandoned. The Western Union linemen are at work on a new line which is to be much stronger and heavier than the old one, and follows the line of the railroad. The company found it very difficult to keep the old line through the Temescal Cañon in repair.

Western Union Wires to Go Underground.—The Western Union Telegraph Company, of Minneapolis, Minn., has been making preparations to place its wires underground. The arrangements have been completed, and the company has applied to City Engineer Rinker for permission to lay conduits. The overhead wires will all be removed. The conduit that the Western Union Company proposes to use is a very simple one, consisting only of a three-inch iron pipe, through which a lead-covered cable containing 75 wires will be drawn. In some places two cables will be used.

The Postal Telegraph in England.—A dispatch from Washington says that interesting accounts have been received at the Post Office Department from Henry George, Jr., a newspaper correspondent now supplying a syndicate of American daily papers with letters from England, touching the postal telegraph system in that country. He says that the charge for telegrams to all parts of the United Kingdom is one cent a word, including the address, the minimum charge being 12 cents, for twelve words or less. Ordinary postage stamps are affixed to the messages in payment. A moderate additional charge is made when the addressee lives beyond the limits of the free delivery. The cost of a reply not exceeding 48 words may be prepaid, and a "reply form" is then delivered to the addressee, who can send his reply from any telegraph office within two months. Five figures are counted as one word. As a measure of economy, where many messages are likely to be sent, an abbreviated or arbitrary address may be registered for $5 a year. The Delany multiplex is one of a number of American inventions in use in England, by which it is possible to send out six messages over a single wire at one time. The British government pays $10,000 a year royalty on it. A great amount of work in a very short time is accomplished in the English postal telegraph system by the Wheatstone automatic process, transmitting 400 words a minute, and used in newspaper telegraphic work.

THE TELEPHONE.

Tampa and Bartow, Fla., will be connected by a telephone line.

Harlem and Appling, Ga., are soon to be connected by a new telephone line.

New Bath, N. H.—A movement is on foot to extend the New Bath telephone line to Lisbon, N. H.

Portland, Me.—The New England Telephone and Telegraph Company has a large number of men setting poles for new lines.

McKeesport, Pa.—A local telephone company has been organized for the purpose of giving the city a complete telephone service.

Keane and Marlboro, N. H.—A telephone line between the points named has been reconstructed with substantial chestnut poles 28 to 30 feet high. A metallic circuit to the eastern part of the State by this line is contemplated, and will probably be put in operation next summer.

Parkville, Mo.—The Park College managers are considering the advisability of establishing a private telephone service in the college buildings. It is proposed to have about 15 telephones in the circuit, and these will be placed in the rooms of the different professors, and at their residences.

From Steubenville to Pittsburgh, Pa.—Work has been commenced on the new telephone line between these two cities. A number of towns along the line will also be connected, one of them being Burgettstown. The poles have been set for a distance of several miles at the eastern end of the line.

From Pensacola to Milton, Fla.—Mr. J. M. Ackerman, manager of the local telephone exchange at Pensacola, says that the poles for the new telephone line to connect Pensacola to Milton are being put in place as rapidly as possible. The length of the line to be built is about nine miles, and it is thought that it will be in operation by Sept. 1.

To Avoid Disturbance from Railway Wires.—The Delaware and Atlantic Telegraph and Telephone Company, of Wilmington, Del., is now at work placing its wires in such condition that they will not be affected by the wires of the electric railways operating at that place. Very high poles are being erected so that the telephone wires may be placed as far as possible above the railway wires.

No Advance in Rates.—The statement that the telephone rates are to be increased at Newburyport, Mass., has been denied by Manager Welch of the local exchange. The service throughout the city is to be entirely reconstructed and the McCluer system of return circuits is to be introduced, but there will be no advance in prices. Manager Welch deserves credit for securing the installation of this system.

The Clifton Forge and Covington Telephone Company, of Covington, Va., was organized July 28th with the following officers: J. M. Buck, president; J. W. C. Bryant, vice-president; and G. T. Shepperd, secretary and treasurer. The company has applied for a charter. Its object is to erect telephone lines, and its field of operations will be Alleghany, Bath, Rockbridge and Augusta counties in Virginia, and Greenbrier county, W. Va.

Improving the System in Maine.—Six inspectors from the general office of the New England Telephone and Telegraph Company are at work in Lewiston, Me., inspecting the telephones and giving the system generally a thorough overhauling, and improving it in every possible way. They have already examined the systems at Biddeford, Saco, and Portland, and will visit all the cities of Maine. The inspectors are putting in circuit protectors to guard the instruments against damage by electric light and power currents.

Opposition to Telephone Charges.—The druggists of Baltimore, Md., in their fight against the alleged exorbitant charges of the Chesapeake and Potomac Telephone Company, have enlisted the sympathy and support of many other telephone subscribers in that place. They have organized an association to conduct the fight, and it is said will make an appeal to the Legislature which meets next winter. The doctors, undertakers and livery stable proprietors are supporting the druggists in their contest. The company has as yet made no concessions. Besides the Druggists' Association the Telephone Subscribers' Protective Association has been organized to fight the company; 170 out of the 184 druggists using telephones have pledged themselves to discontinue their use if the charges are not reduced.

An Appeal in a Telephone Case.—The attorneys for the Delaware and Atlantic Telegraph and Telephone Company have filed a writ of error in the United States Court in Wilmington, Del., for an appeal to the United States Circuit Court, which holds its first session in Philadelphia in the early part of September. Should a decision be rendered against the company in this court, it is said that an appeal will be made to the United States Supreme Court. It will be remembered that Judge Wales in the district court of Delaware about four weeks ago decided that the Telephone company should furnish a telephone for the office of the Postal Telegraph Company in Wilmington; the attorneys for the Telephone company at once took objection to the decision and immediately prepared a writ of error, which they have just filed.

THE ELECTRIC LIGHT.

Tolono, Ill., is to have electric lights.

Ellicott City, Md., is to be lighted by electricity.

Woodsville, N. H., is increasing its electric light plant.

Athens, Ga.—A new dynamo is to be added to the electric light station.

Aurora, O., is agitating the question of a municipal electric lighting plant.

Riverside, Ill.—A contract has been let for a new central station at Riverside.

Elkhart, Ind.—A new dynamo has been added to the plant of the electric lighting company.

Haverstraw, N. Y.—The new electric light plant was put in operation for the first time last week.

Carthage, Ill.—A stock company has been organized for the purpose of erecting an electric light plant.

Waterbury, Conn.—The new 450 h. p. engine at the electric light plant was started for the first time last week.

Kansas City, Kan.—The City Council proposes to purchase the plant of the Consolidated Electric Light and Power Company, for $340,000.

Mascontah, Ill.—A stock company composed of home capitalists has been incorporated for the purpose of establishing an electric light plant.

Portage, Wis.—For the first time in the history of the city the streets are illuminated by arc lights. The plant is said to be an excellent one.

Trenton, N. J.—The State Library has been wired for electric lights. The work has just been completed and the library re-opened for public use.

Columbia, Pa.—A 150 h. p. engine, built by the Stearns Manufacturing Company, of Erie, Pa., is being placed in position at the electric light station.

Fort Wayne, Ind.—A party of councilmen from Greenville, O., were in Fort Wayne last week looking over the system of street lighting used in Fort Wayne.

Waynesboro, Pa.—The Town Council has granted a franchise to an electric light company for the construction and operation of an electric light and power plant.

Concord, Mass.—It is reported that there is a scheme on foot to use the water power of the Merrimac River to furnish Concord with electric lights, and electricity for power purposes.

Manistee, Mich.—The Sands Electric Light Company has ordered a new engine for its works, and has also placed an order for upwards of a thousand dollars' worth of other additions to the plant.

Steilacoom, Wash.—The lowest bid on the electric light plant for the Lunatic Asylum was that of the Edison General Electric Company at $1,335. This bid was accepted. Four hundred dollars was allowed for the old dynamos.

The Salt Lake City Power, Light and Heating Company has found it necessary to make a large increase in its power plant, and has ordered two additional Armington & Sims engines from the Pond Engineering Company, St. Louis.

Brookline, Mass.—William F. Lance, a lineman of the Brookline Electric Light Company was instantly killed last week while in the central station by losing his balance and falling into the 18-foot driving wheel on the main line of shafting.

Colfax, Wash.—The electric lighting plant was destroyed by fire last week. The fire originated in a pile of sawdust which was intended for use in the furnaces. The loss is stated as $11,000, covered by an insurance of about half that amount.

Electric Light in Diving Operations.—At Freidensville, Pa., two electric lights have been put 50 feet under water in the Lehigh River to aid divers who are carrying on some explorations and doing some work under the water at that point.

Willimantic, Conn.—The Citizens' Gas Light Company, organized a few months since, has purchased the Willimantic Electric Light Company's plant, which is operating at the present time over 100 arc lights. The price paid for the plant was $30,000.

Haverhill, Mass.—A contract was closed last week with the Edison General Electric Company by Knipe Brothers for an electric lighting plant at their Ward Hill factory. The plant will have a capacity of 200 incandescent lights and a few arc lights.

E. F. Van Ness & Co., of Valparaiso, Ind., have arranged to install an electric lighting plant, and have purchased their machinery, including two steel boilers, and an Armington & Sims engine. This order was placed with the Chicago office of the Pond Engineering Company.

The Fort Wayne Electric Company, of Fort Wayne, Ind., has sold an arc plant to replace the large electric station recently destroyed by fire at Staten Island. The city of Wheeling, W. Va., has also contracted with the Fort Wayne Company for a large plant to light its streets, the contract being $75,000 to $100,000.

Fire in an Electric Light Station.—The boiler house at the rear of the Incandescent Electric Light Company's station at Atlantic City, N. J., was recently destroyed by fire. It is supposed to have originated from over-heating of the wooden work which was close to the top of the furnaces and was covered with tar paper.

The Sioux City Gas Light Company, of Sioux City, Ia., is making some extensive changes in its power plant, and will put in two large Armington & Sims engines. This company has been using a 400 h. p. engine of this make for some time past. The Pond Engineering Company of St. Louis has the order for this additional work.

Schenectady, N. Y.—The Westinghouse Illuminating Company's plant at Schenectady has been sold to Samuel Insull, John Kruesi, W. E. Gilmore, William B. Turner, and others connected with the Schenectady works of the Edison General Electric Company. The new company will furnish power for the electric railway the city's arc lamps, and for house illumination.

Key West, Fla.—On the 8th inst. the Ball Engine Company, of Erie, Pa., shipped eight carloads of machinery to the Key West Gas and Electric Light Company, of Key West, Fla., consisting of three large engines, two boilers, pumps, heaters, condensers, piping, etc. The Key West Electric will build one of the most complete plants in the South.

A Plant Sold at Auction.—The electric light plant at Henderson, N. C., was sold last week at public auction. The plant has been in operation two years and originally cost about $16,000. It was sold at the auction to Mr. A. C. Zollicoffer for $2,201. Provided the owner can make satisfactory terms with the town the plant will be kept in operation, otherwise it will be shipped elsewhere and sold.

Street Lighting Statistics.—The Census Bureau has issued a bulletin on the social statistics of cities, which was prepared under the direction of Dr. John S. Billings, expert special agent of the Census Office. Information is given in regard to streets, street lighting, water-works, sewers, police and fire departments of 50 of the larger cities in the United States which have furnished the information asked for. As to street lighting, the bulletin shows that the annual cost of each gas lamp varies from $50 in New Orleans, $43.80 in San Francisco and $37 in St. Louis to $15 in Indianapolis and Canton, $15.60 in Minneapolis and $17.50 in Hoboken. The annual cost of each electric lamp varies from $440.67 in San Francisco and $237.25 in Boston to $58.46 in Denver and $68 in Chicago. In cities having over 100,000 inhabitants the average number of lamps to each square mile is 219, or 13.5 to each mile of street, the number of population to each lamp being 47, and the average annual cost of street lighting per head of population 67 cents. With three exceptions, every city of the 50 under consideration uses electricity n whole or in part for street lighting.

THE ELECTRIC RAILWAY.

Meadville, Pa., is agitating the subject of an electric railway for its streets.

From Lowell to Lawrence, Mass.—Capitalists in these two cities are discussing the project of constructing an electric road from one city to the other.

Concord, N. H.—The directors of the Concord Electric road have voted to proceed at once with the construction of the West End electric line as soon as the necessary permission is obtained from the city.

Lebanon, Pa.—The attorney for Henry G. Heilman and others, in the injunction proceedings against the Lebanon and Annville Electric Railway Company, is taking the necessary steps to appeal the case to the Supreme Court.

Altoona, Pa.—Mr. Thomas C. Wiley, of Lancaster, contractor for the Lebanon & Annville Electric Railway, has been awarded a contract for an electric railway from Altoona to Hollidaysburg. The line will be nine miles long.

Asbury Park, N. J.—Contractor A. A. Taylor has a large force of men at work on the new power station of the Seashore Electric Railroad Company. It will be remembered that this plant was recently entirely destroyed by fire.

Rochester, N. Y.—The directors of the proposed electric railway from Rochester to Fairport have concluded to run their road from Cobb's Hill through Pittsford to Fairport. Petitions for right of way are now being circulated.

Lockport, Pa.—An electric railway to Mill Hall is projected and capitalists from out of town who are interested in the scheme are expected to arrive in a few days and look over the field preparatory to the organization of a company for building the road.

Macon, Ga.—The Metropolitan Street Railway Company has recently ordered from the Ball Engine Company, of Erie, Pa., a complete plant consisting of a 150-h. p. tandem compound engine, boiler, heater, pump, etc. The company expects to have a very complete plant.

To be Fitted With Air Brakes.—The electric cars on the Pittsburgh and Birmingham (Pa.) Electric Railway are to be fitted with air brakes. The brake to be used is known as the Genett, and is manufactured by the Western Steam and Street Railway Equipment Company, of Chicago.

Seattle, Wash.—A contract has been let to the Thomson-Houston Electric Company for motors to operate the Grand street electric line. Six cars will be used at first, and it is intended to have the road in operation in four months. The contract calls for the delivery of the cars about Nov. 1.

Pittsburgh, Pa.—Dravo & Black, the Pittsburgh representatives of the Ball Engine Company, of Erie, Pa., have sold the Braddock (Pa.) Street Railway Company a 100-h. p. Ball engine, and a boiler, heater, pump, etc. They have also sold the Pittsburgh Plate Glass Company two 150-h. p. Ball engines.

Electric Railways in Brooklyn, N. Y.—President Lewis, of the Brooklyn City Railroad Company, said last week that it was possible that the application for the right to use electricity on all its lines might be allowed to lapse, and a special application be made for the Court street, Hamilton avenue and Third avenue lines.

Electric Signals on Street Cars.—The cars on the new cable railway in San Diego, Cal., have electric push buttons, with which the passenger is able to notify the gripman when he desires the car to be stopped. Dry batteries are used for the electric bell service, and it is found to be less trouble to maintain the batteries than to replace broken straps.

Beverly, Mass.—The Beverly selectmen at a recent meeting refused to grant the request of the Beverly & Danvers Storage Battery Company to run over the Naumkeag Street Railroad tracks on Rantoul and Cabot streets. The storage battery cars had not been running for the week preceding this action of the selectmen. A petition has been circulated asking the Naumkeag road to extend its trolley system to Beverly.

A Good Year's Record.—During the year ending June 30, 1891, the Second Avenue Passenger Railway Company, of Pittsburgh, operating the Thomson-Houston and Westinghouse electric systems, carried 1,808,993 passengers, according to its recently filed report at Harrisburg, and but twelve persons were injured, the accidents, however, having been due to carelessness or inattention on the part of the injured persons. The receipts of the road for the year were $88,492.45, and the expenses, $61,094.94.

Brockton, Mass.—It is rumored that the Brockton Street Railway Company is about to consolidate with the East Side Electric Railway Company and operate one system of electric cars on both lines. The East Side company was originally equipped with the Sprague system, and the line has since been extended to Whitman, Mass. The Brockton Street Railway Company's lines, however, are operated by horses. The latter company operates by far the greater part of the street railway lines in Brockton.

GENERAL APPLICATIONS OF POWER.

To Run Sewing Machines.—Mr. Frank Lindsay, a Peoria, Ill., tailor, has introduced into his shop an electric motor for the purpose of operating all his sewing machines.

The Electric Transfer Table in use in the Denver shops of the Union Pacific R. R. is said to be giving excellent satisfaction. The transfer table is 70 feet long and has a capacity of 225,000 pounds.

Two Mining Locomotives of 25 h. p. each have been ordered from the Thomson-Van Depeole Mining Company; one of these is for the Shawmut Coal Company and the other for the Noble Coal Company's mines.

Chester, Pa.—The Arnold Electrical Manufacturing Company, of Chester, has just been awarded the contract for furnishing motors, fans and other electrical apparatus for the cruisers Maine and Texas, now building at Portsmouth and Brooklyn navy yards, by the Government.

Mining Tramway.—The Edison General Electric Company has contracted to supply the Nanaimo mine of the new Vancouver (B. C.) Coal Company, the first electric mining tramway on the Pacific Coast. The plant will entirely replace the mules used in coal hauling in the pit, and increase the output capacity nearly three-fold.

The Michales Electric Mining and Machine Company is engaged in the construction of an electric mining plant at the coal works of O'Neil and Patterson on the Monongahela River. This plant will be completed within a few days. The Michales Company has done a good deal of work of this character in the Pittsburgh coal district, all of which has given satisfaction.

Electric Power in Mining.—The Colville, Washington, *Republican* says: "The Gold King mill is proving a great success. It runs the 40 stamps, the two crushers, and helps to run the tramway without calling out all its power. The machine runs smoothly and without the slightest noise, and is perfectly self-regulating. It requires no especially trained labor to run it, as everything is so simple. The engineer formerly running the engine on the Gold King is now looking after the motor, and this without any special training. The power is a perfect success."

An Electric Motor to Turn the Bridge.—The Rush street bridge in Chicago, one of the largest drawbridges in the world, is now operated by an electric motor. In place of the engine and engine house on the top of the bridge an electric motor, which is placed out of sight underneath the bridge, has been substituted. The saving in weight by the change from the heavy engine, engine house, shafting and gearing, to the electric motor will be about 40 tons. The vibration caused by the motion of the steam engine at nearly 20 feet above the centre of gravity of the bridge is also removed. It is estimated that the entire cost of operating the bridge by electricity will be not more than $150 a month. The total cost of the installation was about $3,000. Power is supplied through an underground conductor from the station of the Chicago Arc Light and Power Company. The conductor is carried under the river to the central pier, and is connected with the motor by means of a system of trolleys running on tracks placed at the base of the drawbridge. The motor and its connections, which were constructed from plans made by Mr. George P. Nichols, of the Thomson-Houston Electric Company, have been put in place by the latter company. A similar apparatus has been in successful operation for two months on the Grand avenue bridge, the largest drawbridge in Milwaukee. The Rush street bridge in Chicago weighs 800 tons.

LEGAL NOTES.

Judgment Entered.—Judge Howard Carrow has entered judgment in the Supreme Court at Camden, N. J., for $2,300 for Elmore Applegate against the Applegate Electric Door Mat Manufacturing Company, and for $1,200 for E. A. Ewen against the same company. The plant has been sold by Sheriff West. Joseph E. Roberts purchased the fixtures for $300.

Electric Mining Machinery Patents.—A suit has been brought in the Court of Common Pleas in Pittsburgh, Pa., to determine the ownership of certain mining inventions. The suit is brought by Samuel S. Brown and Frank Glaser against the Electric Mining Machinery Company, composed of George L. Artz, F. M. Lechner, William Lechner, Eugene Ingold, and William L. Pierce.

Telephone Infringement Suit.—The Bell Telephone Company has commenced suit in the United States Court at Grand Rapids, Mich., against Rev. Dr. Chas. Fluhrer and E. A. Moseley, whose sons, however, are the real offenders in the case, and John W. Chase, an electrician. The boys are 16 or 18 years old, and among other inventions have constructed telephones which the Bell company claims are infringements on the Bell patents.

Enjoining the City.—A petition has been filed in the Superior Court by the Cincinnati Edison Electric Company to enjoin the city from interfering with the laying of conduits in certain specified streets. The company relies upon the decree obtained from the Probate Court granting it a right to lay such conduits. From this decree, owing to the lapse of time, no appeal can now be taken. The company informs the Court that it has already put $600,000 into its plant in this city, and has obligations outstanding which will carry the total amount invested here up to a million dollars. It denies that it has injured the streets or any private property, or that there is any danger of its so doing. Judge Smith, to whom the petition was presented, granted a temporary order as to the Board of Administration, but declined to include in it the Mayor and Chief of Police.

PERSONALS.

Mr. David Chalmers is now purchasing agent for the firm of Alexander, Barney & Chapin.

Mr. F. S. Palmer has resigned his position as general manager of the Ellsworth Electric Illuminating Company.

Mr. B. Horton has resigned his position as electrician of the Fenton (Mich.) Electric Light and Power Company.

Mr. John Frost, a young English draughtsman, who was recently in the employ of the Allegheny Electric Light Company, committed suicide last week.

Mr. J. R. Hardy, late superintendent of the Hannibal & St. Joseph Railroad, has been offered the position of general manager of the Augusta Electric Railway Company.

Mr. G. W. Atterbury, of St. Louis, Mo., representing the Westinghouse Electric and Manufacturing Company, was in Hutchinson, Kan., last week on business for the company.

Mrs. Morris Mead, wife of Superintendent Mead, of the Bureau of Electricity at Pittsburgh, Pa., died last week at her home in Pittsburgh.

Mr. Charles H. Greenleaf, of Bath, Me., is now presiding at the treasurer's desk in the office of the Eastern Electric Construction Company.

Prof. F. A. Bateman, of the Genesee Business University, has resigned to accept the position of superintendent of the electric car lines in Marion, Ind.

Mr. S. Fred Smith has retired from the management of the Salem (Mass.) Telephone Exchange to take the position of manager of the Salem Electric Light Company.

Mr. Arthur S. Temple has resigned his position as manager of the Salem (Mass.) Electric Light Company, to assume the management of the Lamson Storage Service Company.

Mr. J. G. Brassell, formerly of Chicago, has assumed the management of the Postal Telegraph Company's office at Chattanooga, Tenn., *vice* J. P. Pemberton, resigned.

Mr. H. F. J. Porter's appointment by Chief Burnham as assistant mechanical engineer of the construction department of the World's Fair has been confirmed by the committee on grounds and buildings.

Mr. Thomas O. Drill, who has been for a long time with the Western Union Telegraph Company in the Georgetown, D. C., office, has been transferred to a better position with the same company in New York City.

Mr. Herbert T. Hartmann, of Fort Wayne, Ind., has been appointed to a position on the engineering staff of the Edison Company for the Canadian district, and will have his office and headquarters at Toronto, Canada.

Mr. Harry Denis, superintendent of the electric light works, at Seneca Falls, N. Y., had one foot badly crushed, on Thursday of last week, by an engine of the Cayuga Lake Park Railway as he was attempting to climb into the cab.

Mr. Andrew J. Robinson, who has been in the employ of the Bangor (Me.) Electric Light and Power Company for ten months past, has accepted a position as foreman in the Augusta & Gardiner (Me.) Electric Railroad machine shop.

Mr. Henry Villard, the president of the Edison General Electric Company, visited Schenectady, N. Y., last week, where he inspected the works of the Edison Company. This is said to be Mr. Villard's first visit to the Edison factory.

Mr. Charles Kroel, who for some months was superintendent of the Fort Wayne Jenney Electric Light Company, of Bloomington, Ill., is said to be a noted swimmer, and recently engaged in a 200 yards' swimming race at the South Chicago Natatorium.

Mr. W. B. Rommel, the well-known electrical engineer of Philadelphia, has accepted the position of superintendent and electrician of the Shamokin Street Railway, which promises to be one of the largest plants of its kind in that section of the State.

James J. Lawrence, the nine-year-old son of President John Lawrence, of the Oregon Telephone & Telegraph Company, arrived in New York on the Aurania last week from England, and started the next day for Portland, Ore. His trip from England to Portland is made entirely alone.

Mr. L. S. Kirby, who has had charge of the electric light works at Washington, D. C., since they were erected, has tendered his resignation to the Lighting Committee. The committee accepted the resignation, and in order to save the salary attached to the position the duties of those employed at the electric light works have been increased.

Mr. J. E. Torbert, assistant manager of the Atlanta (Ga.) Telephone Exchange, has accepted the position of general manager of the Mexican Telephone Company, with headquarters in the City of Mexico. Mr. Torbert is now in New York City conferring with Robert Colgate, president of the company. He has been in the employ of the Atlanta exchange for the past seven years.

Mr. G. W. Hubley has left the employ of the Westinghouse Electric and Manufacturing Company to accept a position as electrical engineer with the Citizens' Traction Company, of Pittsburgh, Pa. The Citizens' company is just about starting its electrical feeder to the present line operated by it under the cable system. This feeder is five miles in length and is equipped with Westinghouse apparatus.

EDUCATIONAL NOTES.

University of Vermont.—The new building for the mechanical and electrical engineering departments at the University of Vermont, at Burlington, is now well toward completion, and Sept. 1 will see it practically finished. The machinery will begin to arrive at about that time, and enough will be in running order at the opening of the term, Sept. 30, to begin shop-work instruction. The equipment, including boiler, engine, machinery and tools, will be first-class throughout, and will compare favorably with that of any similar institution in the country.

Ohio State University has a well equipped physical laboratory containing among other apparatus Thomson galvanometers of high and low resistance, Thomson current and potential galvanometers, Weidemann, Kohlrausch and other galvanometers, standard resistance coils with Cavendish laboratory certificate, several sets of resistance coils and bridges, a Kew magnetometer, a gas engine, and the State photometric apparatus. The electrical laboratory there affords excellent facilities for experimental and practical work with dynamo machinery. Machines of the leading makers are provided for incandescent lighting by continuous and by alternating currents, aggregating a capacity of about eight hundred 16 c. p. lamps. Machines for arc lighting, constant potential and constant current motors, a 55-cell storage battery, Sir William Thomson's electric balance for standardizing galvanometers, Siemens' electro-dynamometers, Ayrton and Perry and other ammeters, Cardew, Weston and Ayrton and Perry voltmeters, Deprez & D'Arsonval galvanometers, photometers, steam-engine indicators, prony brakes and floating cradle dynamometers are provided and enable a wide range of experimental work to be carried out. The Columbus Electric Light and Power Company, using the Thomson-Houston system for arc and incandescent lighting and the Brush motors, and the Columbus Edison Company, using the Edison system of lighting, generously allow students not only to inspect their works but also to experiment freely with their machinery and circuits. The physical department is in charge of Prof. Benj. F. Thomas, who is assisted by Mr. Ralph D. Mershon.

MISCELLANEOUS NOTES.

Newtown, L. I.—An electric fire alarm system has been introduced.

To Test an Electric Log.—Rear Admiral Walker of the Navy has been directed to appoint a board of officers, and have either the Vesuvius or the Cushing used for the purpose of testing the merits of a new electric log recently brought to the attention of the government.

Applied Electricity to the Manager.—The following item is from the New Haven (Conn.) *News*: "A. Waddell, an electrician employed in the office of the Hartford and Wethersfield Horse Railroad, has been discharged from employ because he is alleged to have arranged an electrical contrivance so that Superintendent Stewart should receive a severe shock when he attempted to open the door of Waddell's room. Waddell claimed that Superintendent Stewart had no business around there."

New Fire Alarm System.—C. A. Ray, agent of the Gaynor Electric Company, of Louisville, Ky., has submitted a proposition to the Common Council of Flint, Mich., in which the company he represents offers to furnish the city with a complete system of fire alarm, with 15 boxes, for $2,600. Extra boxes will be furnished for $125 each. The proposition was referred to the special committee appointed at the previous meeting of the Council to investigate the matter of a fire alarm system for the city.

The Tramway and Railway World is the title of a new publication, which will be published in London on the first day of every month after Nov. 1 next. The American office of this journal will be at 11 Adams street, Chicago, Ill., and the American interest of the journal will be cared for by Mr. Frank X. Cicot. Mr. Cicot has recently made two visits to Europe in connection with railway matters, and while there the question of establishing a high-class illustrated paper devoted to tramway and railway enterprises in Europe was discussed by prominent railway managers, and it was decided to establish such a journal, to be conducted on American principles. A prospectus of the journal has been sent to us by Mr. Cicot.

Industrial and Trade Notes.

The Minatt Electric and Machine Company, 56 Vine street, Columbus, Ohio, is finding ready sale for its new type of compound wound incandescent dynamo for isolated lighting.

The Electrical Supply Company, of Chicago, has issued a little pamphlet giving a very fine view of the exterior of its Chicago establishment, and giving the personnel of the various departments.

The Goshen (Ind.) Milling Company, which has secured the contract for lighting the city of Goshen, has installed a Leffel turbine wheel, 5½ feet in diameter, to drive the electric light dynamos.

The Universal Arc Lamp Company had one of its lamps on the Edison incandescent circuit at the Murray Hill Hotel during the last week, and its brilliant light was the cause of much favorable comment.

The Fowler Waring Cable Company (Limited), of Woolwich, near London, Eng., is using "P. & B." compound largely for coating cables. The Standard Paint Company reports that its exportation of P. & B. is constantly increasing.

The Eclipse Blue Print Works has opened offices in the Electrical Exchange Building, 136 Liberty street, New York City, and is ready to furnish blue prints, mechanical drawings and tracings as desired. The firm has already secured a large trade among the electrical fraternity.

Burgess & Boyd, of 216 High street, Columbus, O., have received many indorsements of the portability, convenience and durability of the Burgess Gem, No. 5, electrician's gasoline furnace, from electric railways and electric light companies. The furnace weighs but 13 pounds and is only 11½ inches high.

The Phosphor-Bronze Smelting Company, Ltd., of 512 Race street, Philadelphia, has issued its price list No. 8, giving prices of roll and sheet phosphor-bronze, and telegraph, telephone and other wires made of the same material, as well as phosphor-bronze rods, bolts, screws and other specialties.

The Manhattan Electric Supply Company, of Cortlandt street, New York City, is introducing a novelty to the trade in the shape of its "early risers'" clock, combined with a medical coil, and using only one of the new "Mesco" dry cells. By this combination one gets the extra advantage of a medical battery at a very small increase in cost.

The New Process Raw Hide Company, of Syracuse, N.Y., has received the following letter from Mr. Pierce Butler, of the Wilkesbarre (Pa.) and West Side Railway Company: "We have been using your raw hide armature pinions for over a year and find them the best and most durable pinion that we can buy. We consider the 'New Process' raw hide the best in the market to-day."

The Hart Snap Switch.—The new five-ampère switch made by Hart & Hegeman, Hartford, Conn., has just been offered to the trade. The switch in general construction is like the larger sizes of the well-known Hart snap switch, combining a positive and long break (a total distance of one inch) with very quick movement. This company is now manufacturing double pole switches, having a capacity up to 100 ampères.

Pelton Water Wheel.—In an article on the subject of electric lighting by water power, which appeared in THE ELECTRICAL WORLD of July 4 last, a plant was described, which is now in use at the Geysers Hotel in Sonoma County, Cal. The fact, however, was omitted in this article that the plant is operated by a Pelton water wheel. A No. 5 machine is used and the experiments described were made with this wheel.

Messrs. Westinghouse, Church, Kerr & Company, of 15 Cortlandt street, New York City, are building for the Missouri Electric Light Company, of St. Louis, two 500 h. p. Westinghouse engines. This company has lately installed a 300 h. p. engine for the Wilmington City (Del.) Electric Railway Company, a 300 h. p. for the Brush Electric Light Company, Baltimore, and two 125 h. p. compounds for street railway use at Washington, Pa.

The Globe Carbon Company, of Cleveland, O., will shortly be located in its new factory at Ravenna, O., where the company's capacity will be increased to a daily output of 100,000 carbons, and where it will have unequalled facilities for the manufacture of carbon specialties. Among the latest specialties that the Globe Company has shipped have been carbon rods 144 inches long and 2½ inches in diameter, two of these carbons being clamped together when in service.

The Ball Engine Company, of Erie, Pa., has issued a new catalogue, a copy of which has been sent us. It contains some beautiful illustrations of the company's latest type of engine and of its various parts, accompanied by full and accurate descriptions of the valves, the governor and other parts of the company's simple and compound engines. The illustrations deserve special mention, because of the clearness with which the various details are brought out in each instance.

James Leffel & Company, Springfield, O., have installed one of their well-known make of turbine wheels, 4½ feet in diameter, and all the transmitting machinery, shafting, etc., in the Edison station at Niles, Mich. Another Edison station which they have equipped is that at Rochester, N. Y., where they have just placed a Leffel turbine wheel of 350 h. p. capacity, while in the Rochester Electric Light Company's plant they have placed a turbine with a transmitting capacity of 550 h. p.

The Sunbeam Lamp under some recent tests has proven itself a lamp that can be relied on. The 16 c. p. lamp uses .53 of an ampère and the 52 volt lamp takes .96 of an ampère. Messrs. W. H. Gordan & Co., the New York agents, report that the demand for these lamps is so great that the capacity of the factory is tested to its utmost in filling orders for 16 c. p. lamps alone. One great advantage of this lamp is its strength of filament which makes it particularly good for steamship and electric railway work.

The Ferracute Machine Company, of Bridgeton, N. J., which has made a specialty for some time of machinery for electrical work, is now building what is probably the largest press that has ever been used for cutting out armature discs. It is built with double columns and two cranks and pitmans, the distance between the columns being 100 inches. It will cut a blank up to 90 inches long and 40 inches wide. The company is also making dies for armature discs to run in this press for one of the largest companies.

The Interior Conduit and Insulation Company, of 42-44 Broad street, New York, has just issued an elaborate catalogue of its various specialties, including, of course, the interior conduit, for which the company was originally organized, and the various accessory parts of the system. Besides this the catalogue contains illustrations and descriptions of the company's standard twin conductor, standard coupling, coupling tool, staple drivers, cut-outs, switches, insulating joints, ampère meters, brackets, arc lamps, etc.

The New Vibration Door Opener now being introduced by Messrs. Stalley & Hall, 32 and 34 Frankfort street, New York City, is making many friends by its perfectly sure action. In the case of old styles much vexation is caused by parties having to wait at the door owing to the failure of the push to act, while the parties inside suppose that the door is open. In the new opener positive action is obtained by giving the button several pushes at once, so that if it fails to open the door at first the vibration caused by the push will be certain to produce the desired result.

Messrs. Pierce Bros., Leominster, Mass., are installing the line fixtures for the Danville (Ill.) Gas, Electric Light and Street Railway Company's new electric road. They have also secured the contracts for the Roanoke (Va.) Street Railway Company, the Worcester, Leicester & Spencer, and the Consolidated Road, of Worcester Mass. Messrs. Pierce Bros. are now doing a very large and profitable business. It will be remembered that when they first introduced the trolley mill fixtures about one year ago, their facilities were very limited, but to-day they are recognized as one of the leading supply dealers in this line, with a rapidly increasing trade.

Milliken Brothers, of 55 Liberty street, New York, and 59 Dearborn street, Chicago, have published a catalogue giving the allowable working loads for the Phœnix columns of iron and steel, for use in various structures. The pamphlet contains full-size sections and details for wrought-iron caps, bases and connections. The work is issued with the permission of the Phœnix Iron Company. It contains 26 plates, giving a mass of detailed information regarding the sizes, weights and strength of the Phœnix columns. In addition to this a large number of half-tone illustrations are given of structures containing the Phœnix columns as applied to various uses.

The Steele & Johnson Manufacturing Company, of Waterbury, Conn., has been crowded to the utmost capacity for the past six months in getting out tools to make the different brass parts used in the construction of electrical switches, sockets, cut-outs, etc., no two of which are alike. The company has never done as much in the electrical line as at present. This is mainly due to shrewd business management of this company, giving it a practical monopoly in this line. The "Model" shade holder for incandescent sockets made by this company has also proved itself a good "seller." Messrs. Coe & Mills will represent the company at the Montreal convention.

The Universal Arc Lamp Company, of 42 and 44 Broad street, New York City, has received the following letter from Chas. D. Shain, the district manager of the Edison General Electric Company. Mr. Shain says: "We beg to inform you that the 14 Universal lamps recently installed at the Central Railroad of New Jersey have been accepted, with the guarantee agreed to by you. We are pleased to see that this matter is now definitely closed, and trust that the lamps may continue to give the satisfaction which they have up to the present time." The guarantees mentioned are such as the company will readily grant to other purchasers. This acceptance is the result of a three months' test against all competitors.

Mr. Harry Alexander, formerly located at 20 Cortlandt street, and 348 West 145th street, New York City, formerly connected with the Daft and Edison Companies, and also with the Thomson-Houston Electric Company as chief inspector of the motor department, has removed to 126 Liberty street, where he will have increased facilities for estimating and contracting for the installation of electric light and power plants, and mining and construction work of all kinds. Mr. Alexander, it will be remembered, some time since re-installed the plant for J. B. & J. M. Cornell, changing it from an arc to an incandescent system, using the same dynamo. The installation created at the time considerable discussion among electrical people.

The Western Electric Company, of Chicago, has sent us its last catalogue, which bears on its title page the date of July, 1891. As usual with this company's catalogues the press work has been well done; it is printed on good paper, none but first-class cuts are admitted to its pages, and the general arrangement and make-up of the catalogue are excellent. It contains illustrations, descriptions and price lists of a very large stock of general electrical supplies, and in addition contains chapters giving valuable information regarding the dimensions, resistances and weights of copper wires, and various other electrical data. The catalogue has no less than 306 pages and its value is greatly enhanced by the index which is given at the end of the book.

The Moore Manufacturing Company, manufacturer and dealer in general electrical supplies at the corner of Hudson and Thirteenth streets, New York City, has sent us an illustrated catalogue which has just been issued. The pamphlet will prove as useful to the buyer of electrical supplies as any that has been issued by the supply companies. The illustrations are particularly appropriate, and the descriptions are very satisfactory. This company has made arrangements for the manufacture of nearly all of the supplies which are catalogued in the pamphlet just issued. The new catalogue contains about 100 pages, and will be found to contain information concerning any particular piece of apparatus which the buyer of general electric supplies would be likely to desire.

The National Electrical Manufacturing Company's Removal.—In connection with the circular issued by the National Electrical Manufacturing Company, of New York City and Milford, Conn., of which notice was made in our last issue, we are informed that the removal was made because it had become necessary on account of the growth of the company's business for Mr. Noyes to spend all of his time at the factory, and that their principal office should be located at the factory. This company has lately made an addition to its factory and is now doing all its own nickel plating. The factory is running night and day. The company will have a New York office under the charge of an appointed agent, and it will probably be in the same building in which the old office was located.

Mr. B. L. Peck, of Detroit, Mich., who has charge of the motor department of the Edison Illuminating Company at that place, was in the city last week attending the Edison convention at the Murray Hill Hotel. Mr. Peck exhibited a lubricating material of which he is the inventor, and which he has had in use for some time, intended for application on motor and dynamo commutators as a substitute for the oil, wax, vaseline and other preparations ordinarily used for this purpose. The material is put up in small sticks about three inches in length and three-fourths of an inch in diameter, is of a dark color and is a good insulator. A sufficient amount of it readily melts when held against the revolving commutator. The material is known as "ebonite" commutator dressing. It is made up of the best and purest compounds, free from acids and other destructive substances. Mr. Peck's Detroit address is 44 Clifford street.

The Buckeye Electric Company, of Cleveland, O., has just issued a trade catalogue and illustrated price lists of incandescent lamps, which it manufactures. This company manufactures lamps to fit Thomson-Houston, Sawyer-Man, Edison, United States, Bernstein and other sockets. During the past year the company has doubled its output, and is at present engaged in the construction of new buildings, which will give a plant with a capacity of 5,000 lamps per day. Regarding its lamps the company says: "We have purchased from the European patentee the exclusive right to manufacture in the United States a filament that has shown remarkable results under a series of severe, extended and expensive experiments, conscientiously carried out with a view of discovering its actual value, and so well satisfied are we that we now offer to users a lamp that we believe to be second to none made in this country, having an average life of 1,000 hours, being fully up to candle power at normal voltage, and requiring but little power to operate."

Arc Lamps on Railway Circuits.—The use of incandescent lamps upon street railway circuits has been somewhat unsatisfactory and expensive on account of the great fluctuation in the candle power of the lamps and their consequently short life. The renewal of lamps has been a prominent factor in the running expenses of every plant. Recognizing these facts the Universal Arc Lamp Company, of 42 and 44 Broad street, New York City, has designed an arc lamp especially adapted for use on street railway circuits. These lamps adapt themselves automatically to all fluctuations of the voltage, constantly maintaining a bright white light. They burn ten in series on 500 volts direct current, and are provided with automatic cut outs, so that if one lamp ceases to burn from any cause, it affects in no way the other lamps in series with it. The company has received from Mr. L. S. Dumoulin, superintendent of the electrical department of the West End Street Railway of Boston, the following letter regarding some of these lamps in use on the West End Railway circuits. Mr. Dumoulin says: "In reply to your inquiry respecting the arc lamps supplied by you, I am pleased to say that they are giving us good satisfaction every way. Our normal current is 500 volts, and we arrange the lamps in series of 10, and although subject to extensive variations of potential, the light is both steady and constant. The twin carbons are a great success and give 14 hours' light without causing any trouble."

H. Ward Leonard & Co.—Mr. H. Ward Leonard, the general manager of the light and power department and also of the intelligence department of the Edison General Electric Company, resigned upon Aug. 3, as was announced in the last issue of the ELECTRICAL WORLD, in order to start an independent electrical engineering business under the above title. The new concern will be an incorporated company under the laws of the State of New Jersey. Mr. Leonard will take with him several well tried assistants who have been associated with him in the past, some of them as far back as 1885. Among those who will thus be connected with the company are Mr. A. St. C. Vance, Mr. E. H. Harrison, Mr. C. H. Bloomer and Mr. August Munning. The company will operate specially in a field which is full of promise for the future and is at present inadequately occupied, namely the transmission of power by electricity and the application

of electric motors to the operation of special machinery, such as is not at present operated by electric motors or whose operation is subject to improvement by careful attention to the requirements of the case. Mr. Leonard's experience since 1883 when he became a member of Mr. Edison's first electrical engineering staff has brought him into contact with every branch of electric light and power work. He has held positions from the lowest to the highest in the exploiting parts of the business, as well as in the constructing and in the operating of all kinds of electric light and power plants, and it is not, therefore, altogether surprising that he should feel willing to resign his office with the Edison Company to take up a line of work which promises so well for one having such an exceptional experience as he has been fortunate enough to have. H. Ward Leonard & Co. will have one important feature of their business which will be entirely unique, namely an electrical intelligence department. To any isolated plant the company offers at a very moderate subscription price the privilege of corresponding upon any electrical subject of practical interest, and thus an isolated plant will be able to secure expert information as to its own plant and the best methods of operating it, and about any new electrical apparatus, or methods and principles underlying various devices and the prices thereof. For central station companies, whose queries would go further into steam engineering and methods of distribution, and would also cover business questions as to the relations with consumers, systems of accounts, etc., the annual subscription charge for this electrical intelligence will be somewhat higher. This scheme seems to be an excellent one, and any plant will probably get several times the value of the subscription price by placing before the company the matters upon which it desires information, data and statistics. As Mr. Leonard created and developed the intelligence department of the Edison General Electric Company, he has had the broadest possible experience in this line, since information of every character issued to those in the Edison Company has been issued by the intelligence department of that company. In case the expert judgment of the company be desired as to the comparative merit of various competing apparatus or methods, such expert judgment will be given by special arrangement, although the company prefers to merely supply full information under the subscription arrangement and allow the purchaser to form his own conclusions. H. Ward Leonard & Co. will do no manufacturing and will do [no supply business, neither will they, under any circumstances, act as the selling agents of any concern, directly or indirectly. They will, however, act for the purchaser, either as consulting engineers, supervising engineers, inspectors or purchasing agents. From the complete schedule, as announced, it appears that the purchaser will be able to obtain the services of this company for any portion of the work and under terms which are so reasonable that there can be no question in the minds of those familiar with the subject that any purchaser contemplating the installation of an electric plant would not only save a great deal of his own time and be spared a great deal of annoyance, but would actually effect a very material saving in retaining the services of a concern such as this to represent the interest of the purchaser. The company will make a specialty of the transmission of power and the application of electric motors to such uses as necessitate the application of a wide experience in both mechanical and electrical engineering. Such applications of electric motors as are met with in elevators, pumps, hoists, mine tramways, printing presses, etc., are those which the new company is especially qualified to undertake.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED AUG. 11, 1891.

457,334. Pole Trolley and Stand for Electric Street Railways; Thomas E. Adams, of Cleveland, O., Assignor to the Brush Electric Company. Application filed June 11, 1889. The combination, with a trolley, of a spark catcher arranged to press against the under side of the line conductor at one end of the trolley.

457,338. Electrical Switch; Harry H. Blades, of Detroit, Mich. Application filed Nov. 3, 1890. The combination, with the main line of an electric motor, a series of terminals and resistances and an electromagnet in the circuit of the motor, of a circuit-switch consisting of a pivoted two-part lever joined at the pivotal point and one part having an armature to co-operate with the electromagnet and a spring acting to maintain the two parts of the lever in line with each other, said armature part of the lever being held by the electromagnet after the other part of the lever is moved to cut off the current from the main line until the motor has come nearly to rest.

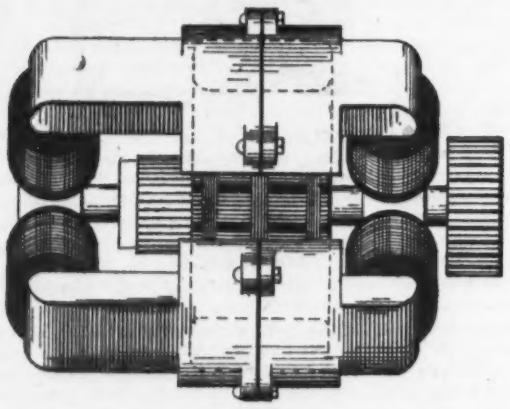
457,339. Electric Switch; Harry H. Blades, of Detroit, Mich. Application filed Nov. 10, 1890. An electric motor, having a hand switch adapted to open and close the circuit of the motor, an electromagnet in the circuit of the motor, an armature carried by a support independent of the hand switch, and mechanism connected with the armature of said magnet adapted to engage and hold the switch in its closed position until the magnet is de-energized by the cessation of current through the motor-circuit.

457,343. Magnetic Belting; Thomas A. Edison, of Llewellyn Park, N. J. Application filed Sept. 10, 1890. A magnetic belt having in combination one or more wire ropes and transverse iron bars, said wire ropes passing through the transverse bars. (See illustration.)

457,356. Trolley Pole for Electric Railways; Charles A. Lieb, of New York. Application filed March 28, 1891. A trolley pole having a tubular metallic conductor inclosed therein.

457,357. Electric Car Motor; Cyprien O. Mailloux, of New York. Application filed March 18, 1891. The combination, in an electric railway motor, of a motor frame made in two parts, one supported on the car axle or truck, while the other part supports the armature and is attachable and detachable from beneath the first, so that it may be lowered with the armature, leaving the upper part in place.

457,358. Brush Holder for Dynamo-Electric Machines or Motors; Cyprien O. Mailloux, of New York. Application filed March 18, 1891. In a brush holder for dynamo machines or



No. 457,754.—Dynamo-Electric Machine or Motor.

motors, a sliding holder or follower for the brush, a holder body formed with guides or ways to prevent the holder from turning, an adjustable head mounted in said body, and an interposed spiral spring between said head and the top of the block or follower which engages directly with or carries the brush.

457,359. Friction Gear for Electric Car Motors; Cyprien O. Mailloux, of New York. Application filed March 18, 1891. The combination, with the driven shaft, of the motor sleeved on suitable shaft or bearing, and having its armature shaft parallel therewith, an interposed eccentric sleeve, and means for rotating the latter to adjust the relation of the gear between the armature shaft and said driven shaft. (See illustration.)

457,362. Electric Steam Generator and Heater; Willis Mitchell, of Malden, Mass., Assignor to the Butterfield-Mitchell Electric Heating Company. Application filed Nov. 29, 1890. In a steam generator, a water reservoir with a heating device consisting of a series of layers alternating with water spaces, a wire forming part of an electric circuit and wound on said layers within said spaces, and inlet and outlet pipes connecting said heating device and reservoir.

457,374. Safety Device for Electric Wires; John H. Sedlmeyer, of Johnstown, Pa. Application filed Oct. 23, 1890. The combination with the main conductor or line-wire of a normally dead conductor parallel therewith, a clock mechanism, a spring-retracted switchlever connected with the line wire and held in engagement with its contact point by said clock mechanism, a detent lever forming part of the clock mechanism, an armature lever engaging said detent to release it, and an electromagnet for operating the said armature and electrically connected with the normally dead wire.

457,377. Trolley for Electric Railways; Sidney H. Short, of Cleveland, O., assignor to the Short Electric Railway Company, of same place. Application filed Nov. 6, 1889. A trolley shoe constructed with a receptacle and a spring in said receptacle, and a contact block located in the receptacle and adapted to be pressed against a trolley-wire by said spring.

457,378. Trolley; Sidney H. Short, of Cleveland, O., Assignor to the Short Electric Railway Company, of same place. Application filed March 26, 1890. The combination with a base, a swivel-pin thereon, and a block having a vertical socket in its lower end adapted to receive the swivel-pin, and a horizontal bearing located directly above the upper end of said socket, the said block being mounted on and supported by the upper end of said pin, of an arm mounted on said bearing and carrying at its upper end a contact wheel or brush and connected at its lower end at a point below its axis with a spring.

457,382. Electric Railway; Michael Holroyd Smith, of Halifax, Eng. Application filed Dec. 16, 1887. An electric railway having two parallel positive conductors in one horizontal plane, two parallel negative conductors in another horizontal plane, and cars carrying collectors arranged to make contact with all the said conductors simultaneously.

457,407. Self-Regulating Electric Converter; Thomas Spencer, of Pittsburgh, Pa. Application filed Dec. 17, 1890. An electric converter consisting of a core of soft iron, a primary coil carried thereby, a secondary coil wound upon a different portion of the core and having a portion of its convolutions remote from the primary coil wound in the reverse direction from the balance thereof.

457,430. Electric Battery; Flavien Poudroux, of Paris, France. Application filed March 6, 1891. In an electrical battery, a carbon and zinc element having a solution between them consisting of azotate of potash, binoxide of manganese, bichromate of soda and sulphuric acid in water, in combination with a second carbon element having between it and the zinc element an exciting solution consisting of chlorhydrate of ammonia and azotate of potash, and an outer enclosing cell or casing containing a second depolarizing solution in contact with the said second carbon element.

No. 457,457.—Electric Oil Well Heater.

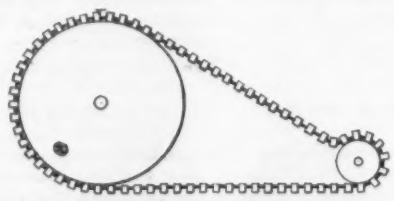
457,453. Electric Meter; Eugene Meylan and Wencleslas Camille Reckniewski, of Paris, France, Assignors to Réné Heurtey, of same place. Application filed Nov. 10, 1890. An electric meter consisting of an electric motor of constant speed, an electric balance elastic cam, a totalizer, and a coupling device adapted intermittently to impart the action of said motor to said totalizer under the operation of said cam, the whole adapted to effect automatically at regular intervals a record of current upon said totalizer.

457,454. Annunciator; Walter R. McCann and Simon S. Creider, of Sterling, Ill. Application filed April 23, 1891. The combination of an indicating device, a mechanical actuator therefor, a circuit closer controlled by such actuator, and a magnet included in a circuit with said circuit closer, said magnet also actuating said indicating device to increase its movement.

457,457. Electric Oil Well Heater; Chas. W. Robison and Sam D. Robison, of Allegheny, Pa., Assignors of two-thirds to Robt. B. Robison and John G. Lucock, of same place; John A. Gartlan, of Pittsburgh, and Thos. D. Williams, of Bellevue, Pa. Application filed Feb. 18, 1891. In apparatus for removing paraffine from oil-wells, the combination of a water-tight case, an electrical heating coil therein, a supporting rod, and two hollow rods containing the conductors and attached to the upper part of the case. (See illustration.)

457,477. Automatic Telephone System; Hammond V. Hayes, of Cambridge, and Henry D. Sears, of Lynn, Assignors to the American Bell Telephone Company, of Boston, Mass. Application filed Feb. 3, 1891. In a telephone exchange system capable of being operated from the several subscribers' stations, a series of lines converging from sub-stations to a central station, a constantly operating circuit changing signal transmitter at the central station for each line connected with said line when at rest and transmitting thereover the designating signal thereof, a motor driven circuit-changing drum for each line, also at the central station controlling the normal closed terminal of its own line and normally discontinuous branch terminals of all lines, each drum being normally under the control of the sub-station of its own line and adapted to revolve when started thereby, and thereupon to disconnect its own designating signal apparatus and to successively connect in place thereof the designating signal apparatus of each of the other lines, and a telephone at each sub-station, wherein the said designating signals can be reproduced, whereby the operator at each sub-station may be notified as each line successively is brought into connection.

457,483. Automatic Electric Circuit Switch; William L. Silvey, of Lima, O. Application filed April 19, 1889. The combination of a pivoted switch lever, a flexible electric conductor connecting the lever to the main line circuit, a carbon-holding device, a hook attached to the switch lever, a pivoted switch latch-engaging the hook on the switch-lever, a spring for holding them in engagement, a screw for regulating the tension of the spring, an electromagnet whose coils are in circuit with the switch lever and its contact points, an armature attached to the switch latch, a split contact for making electrical connection with the switch lever, a carbon point mounted on the switch contact, a carrier therefor, and a forwardly propelling device for moving the carbon and carbon carrier, whereby the electric circuit is maintained be-



No. 457,343.—Magnetic Belting.

tween the carbon contacts until the switch-lever and split contact plate have become entirely separated.

457,534. Electric Motor; Warren S. Hill, of Boston, Mass. Application filed June 23, 1890. An electric motor, the field magnets of which are composed of plates of sheet metal clamped between the end plates, recesses in said end plates, and rods having reduced ends passing through the sheet metal plates and end plates and secured by bolts, whereby the whole is securely clamped together.

457,555. Electrode for Secondary Batteries; Leonard Paget, of New York. Application filed June 5, 1890. An electrode for a storage battery having an active core in contact with the connecting-lug of the electrode and a perforated conducting envelope surrounding the core and insulated from the connecting-lug except through the working faces of said active core.

457,561. Apparatus for Heating by Electricity; Rankin Kennedy, of Kilmarnock, Scotland. Application filed Nov. 20, 1890. In an apparatus for heating by electricity, the combination of a core forming an open or discontinuous magnetic circuit, a magnetizing coil, and a source of pulsatory currents, with a body composed wholly or in part of iron adapted to be placed in the incomplete portion of the magnetic circuit and heated by secondary currents induced therein.

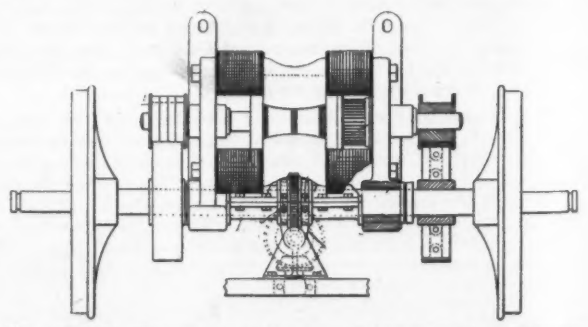
457,565. Signaling Telegraph for Cable Railways; Theodore A. B. Putnam, of New York, Assignor by direct and mesne assignments of seven-eighths to Ella S. Webster and Albert Comstock, of same place, and Joshua W. Powell, of Brooklyn, N. Y. Application filed March 13, 1889. A signal for cable railways, consisting of a bared electric conductor extending along the track in any convenient position, and attached to one terminal of an electric generator, the other terminal being connected with the track. A contact device carried by the car is adapted to make contact with the bared conductor and operate an annunciator at the power house.

457,572. Switch; Sigmund Bergmann, of New York, Assignor to the Bergmann Manufacturing Company, of same place. Application filed Jan. 26, 1891. A switch, having terminals consisting of strips of metal secured at one end to a block of insulating material and spread apart at the other end, connecting pieces opposite and adapted to enter the spread ends of the terminals, and locking device for securing the connecting pieces against the terminals, an electric circuit for operating the locking device, an armature lever, upon which the connecting pieces are mounted, and an electro magnet co-acting with the armature on the lever to force the connecting pieces into contact with the terminals.

457,573. Means for Suspending and Controlling Electric Lamps; Sigmund Bergmann, of New York, Assignor to the Bergmann Manufacturing Company, of same place. Application filed Feb. 25, 1891. An electric switch having a movable part which extends a tube or arm, wires or conductors extending along the tube or arm and depending therefrom and electrically communicating with one part of the switch, whereby the wires or conductors may be made to adjust the switch.

457,657. Wind Apparatus for Generating Electricity and Charging Secondary Batteries; James Madison Mitchell, of Lawrenceville, Assignor of one-half to William A. Camp, of Greenway, Ga. Application filed March 23, 1891. In an apparatus for generating electricity, a wind wheel, a shaft journaled in drum or casing, an armature mounted on said shaft, a field magnet arranged in said drum, a pivotal support for said drum, conductors arranged upon said support and contacting with conducting devices on the bearing for said pivotal support, a working circuit for the dynamo, a derived circuit for said dynamo, and an automatic device closing the working circuit when the dynamo generates a current of predetermined strength and breaking said circuit and making the derived circuit when the current falls below a given point.

457,660. Hanger for Trolley Wires; Nelson Newman, of Springfield, Ill. Application filed Sept. 23, 1890. An insulated hanger having a flat non-conducting base, hooks attached to said base and adapted to engage the supporting wire, and a depending flat metallic web lying at right angles to the base and rigid therewith, the lower end of said web being double or bent upon itself to provide a broad bearing or contact for the trolley wire.



No. 457,359.—Friction Gear for Electric Car Motors.

457,687. Electric Light Hanger; Frank A. Weimer, of Stanberry, Mo. Application filed March 28, 1891. In an electric hanger, a core formed of elastic material, flexible conductors twisted around the said core, and the whole formed into a spiral.

457,736. Electric Railway; Rudolph M. Hunter, of Philadelphia, Pa., Assignor to the Electric Car Company of America, of same place. Application filed June 21, 1886. A conduit for an electric railway, provided on its upper portions with lateral flanges formed integral with the side wall, said flanges being provided with drainage apertures, and having working conductors located within and insulated from said conduit.

457,745. Electrically Heated Oven; Willis Mitchell, of Malden, Mass. Application filed Nov. 29, 1890. An oven or heater provided with successive layers of non-conducting material, and a wire which forms part of an electric circuit and is wound in successive layers between said non-conducting layers.

457,754. Dynamo-Electric Machine or Motor; Edward M. Waring, of Brooklyn, Assignor to himself and James G. White and Joseph F. Porter, of New York. Application filed March 23, 1891. The invention consists of two field magnet systems arranged one upon each side of the armature concentric with the armature shaft or axis of rotation, the pole pieces of each system being connected together to form consequent poles, the whole structure forming a cage inclosing and protecting the armature and commutator. (See illustration.)

457,761. Connection for Electric Conductors; Joseph Dillon, of Larchmont, Assignor of one-half to H. J. Reilly, of New York. Application filed Jan. 16, 1890. The invention consists of a holder constructed to receive and to hold electric conductors, a cover constructed to be applied to said holder and having an eye formed thereon, a fixed support to which said eye may be secured and a locking device to lock the eye to the supports.

457,762. Electric Air Pump; Allen A. Dittmar and Hugo Falkenhausen, of New York, Assignors of one-third to Albert L. Reinmann, of same place. Application filed Jan. 23, 1891. An electric air pump, having suction and discharge compartments communicating with the pump cylinders by valve openings, with solenoids placed over openings in the top plates of the compartments and having movable cores which pass through the openings in the said top plates and act as valve stems, so as to open and close the respective valve openings by electric currents conducted alternately through the respective solenoids.

457,763. Electric Light Carbon; William P. Eltringham, of Dubois, Pa. Application filed April 27, 1891. A composition to be used for producing electric light carbons, consisting of coke, pitch and borax or its equivalents.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1836—can be had for 25 cents. Give date and number of patent desired, and address The W. J. Johnston Co., Ltd., Times Building, N. Y.